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ABSTRACT

This publication is a report of a conference on environmental education at the post secondary level in Rungsted, Denmark, as organized by the Center for Educational Research and Innovation. It includes a review of experience in the field and plans for future action. A number of speeches and committee reports are included. There are three major parts, each concerning a different aspect of environmental education. Part one deals with the organization, preparation, and operation of a post secondary environmental education course of study. Part two reviews the experiences and problems of the programs in the participating countries. The final section reports the need for and guidelines for environmental education research. Two annexes at the end of the publication give a listing of participants in the conference and of literature references. (MA)

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PROBLÈMES D'ENVIRONNEMENT
ET ENSEIGNEMENT SUPÉRIEUR

Centre for Educational Research and Innovation (CERI)

ENVIRONMENTAL PROBLEMS AND HIGHER EDUCATION

Report of a Conference organised by CERI
on Environmental Education
at Post-secondary level : Review of Experience -
Future Action, at RUNGSTED, Denmark
from 4th to 7th June 1974

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT
1976

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Director of Information, OECD
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PREFACE

Institutions of higher learning have always been jointly responsible for dealing with the problems of social change. This responsibility consists in carrying out three fundamental tasks : education, research and community service.

Although the generally monodisciplinary organisation of faculties, departments or schools in the past enabled higher education to perform these tasks for the benefit of society, conditions now appear to have changed.

Questions relating to man and his environnement, and more particularly the problems caused by steadily increasing industrialisation and ever-growing consumer demand, can no longer be dealt with by traditional higher-education structures, especially those of universities. A manifest need which has emerged is that schools, departments and institutes teaching the environmental sciences be developed along horizontal, interdisciplinary lines.

The educational task of these institutions should be to enlighten the ordinary citizen, train future specialists and generalists as well as teaching staff at every level, and organise the further or continued training of decision-markers and certain professional groups (doctors, lawyers, architects and engineers). The research task would be to promote the study and preparation of short-term solutions, together with longer-term studies such as those covering the operation of ecosystems influenced by man. Their service task should primarily be conducted for the benefit of local or regional communities which ask for their assistance.

The present report discusses all these aspects which were debated at a conference held by CERI at Rungsted, Denmark, in 1974.

It is gratifying to note that in the various Member countries many universities or institutions of higher learning have undertaken to further the environmental sciences. These outstanding initiatives are the leaven promising the renewal of higher education and its relations with society on a more general scale.

J.R.GASS
Director,
Centre for Educational Research
and Innovation

ADRESSES GIVEN AT THE OPENING SESSION OF THE RUNGSTED CONFERENCE

ADDRESS BY EMILE VAN LENNEP
SECRETARY-GENERAL OF THE OECD

Your Royal Highness, Madame Minister, Ladies and Gentlemen,

It is a great pleasure for me, as Secretary-General of the Organisation for Economic Co-operation and Development, to open this Conference dealing with education and the environment. The people of Denmark have demonstrated in many ways their resolve to harness economic development to the improvement of the natural and social environment. The participation in this conference is ample evidence of the world-wide character of these problems. In addition to the distinguished Danish personalities, the importance of this gathering is heightened by the presence of many recognised experts, national representatives from both hemispheres, and members of several international organisations. I would like in particular to welcome on behalf of the OECD His Royal Highness Prince Henrik, Miss Tove Nielsen, Minister of Education, and my honoured predecessor at the OECD, Professor Thorkil Kristensen.

Ladies and Gentlemen, when the history of the quarter century following World War II is written the extraordinary capacity of the advanced industrial nations to manage their economies so as to maintain steady economic progress and high levels of employment will surely be an outstanding feature. In the troubles of the moment we should not forget that simple reality. But, like so many other remarkable achievements, this progress has brought complications as well as rewards. We are dependent on economic growth to bring the benefits of material progress to all citizens, to solve our social problems, and to give aid to developing countries on the scale that is needed. However, is it inevitable that the process of growth should take the form of ever-increasing industrialisation, the growing predominance of the urban mode of life, and those forms of spending which typify the "consumer" society - thereby transforming the natural and social environment in ways which may be detrimental to quality of life ? The challenge for the coming quarter of the century is to make our economic systems serve the human and social purposes which, in the last analysis, are their "raison d'être". The methods of organising production must reflect the right of all citizens in the labour force not only to adequate income but also to satisfying work. A more balanced process of growth must produce equal opportunities and benefits for both urban and rural sectors. The international division of labour and the consequent movements between countries of people, capital and technical "know-how" must reflect the opportunity of all nations, both developing and developed, to share in the benefits of economic prosperity. In a word, economics must be more clearly oriented to its basic purpose : the welfare of people on a world-wide scale.

The OECD advocates the need for this broader concept of growth : a reconciliation of material progress, social advance and welfare for the individual citizen, and better distribution of wealth around the world. Early in the 1960s the Organisation recognised that economic growth, as a principal objective, was dependent on the skills and inventiveness of people, and therefore that expenditure on education and scientific research was an investment in economic growth as well as a social necessity. Today the educational and scientific communities play an important role in the work of the Organisation, as witnessed by the participants at this Conference. In the late 1960s the earlier objective of economic growth was broadened to include the improvement of the quality of life. As a result of these wider concerns, the Organisation first began to explore possible means for the control and management of environmental side-effects of growth, and, second, launched a programme of social indicators to serve as "signposts"for economic and social progress. Today,in 1974, the OECD is responding to the problem posed by the energy crisis and the growing scarcity of raw materials as a potential disruption in the economic and technological balance between countries which may have widespread social ramifications.

Even if the grave problems brought on by the cumulative effects of the energy crisis and inflation are bound to occupy the centre of today's scene for an international economic Organisation such as the OECD, they should not divert us from the fundamental, long-term goals of our economic and social policies. The appearance of new problems in the areas of the human environment, education,energy and raw materials are full indications of the changing circumstances of economic development. While such circumstances may occasionally force us to concentrate on individual issues, an increasingly human and just process of growth must remain our central goal. To enrich rather than to damage the environment - which after all was the heritage of our forefathers - will surely be a major and continuing preoccupation within this broader view of growth.

What is needed is a long-term integrated view of the whole process which pulls together the economic, technical and social elements of the problem, policies for prevention as well as cure, and positive action by governments to assist the market to respond to these needs. The meeting of the Ministers responsible for the Environment in the OECD Member countries, which will take place in November 1974, therefore comes at a propitious moment.

Action at the political level must, however, build on the knowledge, attitudes and skills which only educational institutions, both schools and universities, can create. My predecessor, Thorkil Kristensen, was indeed foresighted when he proposed in 1968 the creation of a Centre for Educational Research and Innovation in the OECD, and encouraged the Centre to take a bold approach to educational change. That was the time of the student revolt, and one of the basic attitudes of students in that traumatic year was that knowledge, as developed in the university, should be made more relevant to society. Today, we are gathered to discuss how the universities have responded : how, without forfeiting freedom and scientific creativity, the world of research and learning can respond to the realities of the environment that surrounds it. Dare I say that this dialogue between knowledge and reality, between the world inside and that beyond the walls of acadaemia, is the essence of, and not the perversion of, the scientific method ? Science, even at the frontier of pure knowledge, is an exploration of reality.

Be that as it may, our hopes of dealing with the problem of the environment lie to a significant extent in the education of those who can see the problems of the environment in an integrated way. The principle of "the polluter pays", by virtue of which the costs of reducing negative side-effects to acceptable levels are borne by those who create them, could be complemented by a more positive approach. The conception and planning of industrial processes should foresee and avoid such side-effects ; a possible complementary principle could then be "the planner prevents". This will only be possible if the institutions of higher education, both in their undergraduate and postgraduate education and in their research and development programmes, are able to reconcile professional specialisation with the real needs of the environment. The new technologies which are needed for sustained economic development will be more readily acceptable if the pollution deriving from these new technologies can be foreseen and prevented by industrial decision-makers. I therefore look upon this Conference as an important event in the endeavour to advance towards positive and integrated environmental planning, in which technological economic, social and human considerations are given due weight.

However, interdisciplinary planning does not come about by chance. In fact, it requires special efforts to overcome the centrifugal forces of specialisation that are everywhere in our post-industrial society. How can we find better ways to prepare people for interdisciplinary work ? How can institutions join in more productive partnerships ? These are problems that must be answered.

It is for this reason that the OECD has watched with intense interest the evolution of the programme that brings us together today. Since 1971 CERI has pursued these issues with the help of many experts. The product of this work is the base from which we begin our deliberations today : 27 cases studies from 8 countries and 10 valuable working papers.

It is my hope that we can move ahead from this solid base of information, so that the concluding session of this Conference will set forth :

- an analysis of the elements that must be brought together for proper environmental education : what disciplines, what content, what practical experience, what students, what teaching methods, what community links ?
- an assessment of our experience : the size and structure of programmes that work best, the optimal educational relationship with industry and job opportunities, the most effective ways to involve students and community in educational planning, the benefits coordinated action can bring to the quality of the world in which we live.
- a prospectus for action that will help guide the future of environmental education itself, but will also reach into broader questions : the lessons that might be applied to other areas of social concern such as health, social services, and employment.

Such results, I assure you, will have an impact in our Member countries and on the international level as well.

Ladies and Gentlemen, let me conclude by expressing my thanks to the many people and organisations who have contributed to this Conference ; the Steering Group and its able Chairman, Mr. Jens Hedegaard ; the experts who have prepared the reports and taken part in the innovative programmes we will be discussing ; all of you who have come so far to participate in our deliberations.

ADDRESS BY H.R.H. PRINCE HENRIK OF DENMARK

Mr. Secretary-General, Madame Minister, Ladies and Gentlemen,

It gives me great pleasure to be with you today for the opening of the Conference on Environmental Education at Post-Secondary Level.

The world environment has acquired a new meaning that is becoming more significant every day. We have realised the importance of our environment because it is now threatened by the spread of cities, the growth of populations and pollution from industry. We are beginning to see Nature in the same light as certain animal species in which we show an interest only when we realise that they are in danger of extinction.

And yet Nature is vast and prodigal. There is living space for all human beings in this world and for many more as well. But whereas previous generations were able to demolish, transform and build with impunity and without damaging the world around them or the heritage of bygone ages, it would seem that more than half-way through the 20th century we have arrived at a stage in which the accumulation of human mismanagement in all areas - architectural, cultural, natural, or even human - now threatens with inexorable destruction a way of life and a civilisation which have been handed down to us through the centuries and mirror our history.

We must of course accept change and move forward, otherwise our civilisation would remain static and sclerosis would set in. But even as we change we must respect and protect nature, that most essential of human possessions, for it is the only environment in which Man can thrive.

The last few decades have wrought destruction that in many cases is irreversible, whether it be along the shores of the Mediterranean, on the plains of North America, on the summits of the Alps or at the approaches to our cities. Industrial civilisation has spread its cancer without regard for landscapes or the human beings who have to live there. To prevent this disease, which is still within bounds, from getting completely out of hand certain organisations and a section of public opinion have sounded the alarm and set forth on a crusade to arouse the community to a danger which may well be irremediable if we do not face up to it with all speed.

The time has come to speak out and to marshall our forces if our environment is to be saved. For a battle will indeed have to be fought and time is not on our side. So it is heartening that the OECD has convened this Conference whose theme "Environmental Education at Post-Secondary Level" shows the importance it attaches to the outcome of this struggle. By its action in enlisting the "post-secondary level" in this crusade the OECD has called up new and absolutely fresh troops who are destined to be the spearhead of operations in the years to come.

In devising new educational curricula directly concerned with the environment and appealing to the young and the not so young to husband both our energy resources and our living space, we are attempting to meet two deep-seated needs : to protect and improve our environment and to train new generations to bring to fruition a policy whose seeds we are sowing today.

I am convinced that your work here will be fruitful and have far-reaching effects not only in your individual countries but also at international level.

I can imagine how much preparatory work has gone into this conference and how lively your discussions will be during the four days it is to last. I want to express my most sincere good wishes for the success of this conference, for I know your enthusiasm and determination and also the interest with which we shall be following your efforts. Your task is not only to ensure that the tree of life flowers in the coming years but also to protect the vitality of its deepest roots so that our society and our whole civilisation can continue to flourish in all serenity.

ADDRESS BY EDWARD W. WEIDNER, CHANCELLOR OF THE UNIVERSITY OF WISCONSIN-GREEN BAY, UNITED STATES

Environmental Education : An Academic Plan for Universities.

Your Royal Highness, Mr Secretary-General, Madame Minister, Ladies and Gentlemen,

The three principal forces in the world today are the explosion of population, the rapid development of social and physical technology, and the revolution of rising expectations. Currently, the population of the world is growing at a rate of almost 100 additional persons per minute. The number of human beings will be doubled in a thirty-year period, if present trends continue. And even if the birth rate is brought down to a mere replacement level, in all countries throughout the planet Earth, it will take several decades before the population increase tapers off, and we finally reach a point of population stability.

The consequences of ever-more-people are far more serious than would be indicated by the simple arithmetic of the population explosion. The resource requirements for each human being are increasing every year. There are several reasons for this. Among them are the escalation of demands on the part of all peoples and the impressive development of social and physical technology year after year on a continuing basis. Such technology responds to human demands for a better life, and in turn makes it possible to develop even greater expectations for the future. But technology is expensive in terms of resources. Each year there is a greater demand for energy, not just in total amount, but in the amount per capita. Each year the good standards are raised. This results in a demand for more, a greater variety of, and higher quality of food stuffs per capita. Each year the demands are raised for housing, transportation, communication, and other valued aspects of our society.

As a result, the depletion rate of some of our natural resources has reached serious proportions. Agricultural land is at a premium. The green revolution has real limitations. The world's use of petroleum and fossil fuels in the last thirty years has created an energy crisis of major proportions. The reserves of several minerals are dangerously low.

Social and cultural resources are being used at an ever increasing rate per capita, as well as those in the realm of the biophysical. The intensity of the use of our political institutions, the heavy stress on the family, and the preponderance of urban society the world around, with all its consequences for the inadequate social institution known as a city - trends such as these place an ever greater reliance upon the social structure or social technology of the world at a time when its development has been pressed to keep pace with events.

The effects of transportation and communication technology, along with worldwide industrialization, threaten the very fabric of honoured and prized cultures. Will the fact of the planet Earth being one world mean that all cultural differences fade ? Will modernization bring a uniformity of values such that there are no true alternatives in patterns of living and beliefs ? This homogenization of cultures is not just a matter of the industrialized world versus the less developed world. Nor is it the West versus the East. The maintenance and strengthening of divergent and complementary cultures is a problem within countries as well as among countries. As people and people become closer, a threat of sameness and loss of identity emerges.

Because of the press of population and the steady growth of human expectation and of physical and social technology, the rate of change in the world is accelerating. There is thus less time to adjust to altered circumstances. What was a residential section of a city one year is a commercial or industrial district another. What was a farming community one year is an urban subdivision the next. What was an unexplored continent one generation is a peopled and interconnected set of living communities twenty years later.

This is the kind of world which higher education must address in the last quarter of the twentieth century. It is a restless world. It is a world demanding action now. It is not a world that can wait.

If universities are to assume a more vital role in society, they cannot afford to wait either. They must re-examine their philosophical basis. They must thoughtfully question their reason for being. They must join the world, rather than considering themselves refuges from it. The world is their focus. Society is their datum. Education, and university education in particular, must become environmental in the broadest sense of that term.

Traditionally, the classical university has tried to remain aloof from society. It has been a retreat, a philosophical Mecca. It has been based on the somewhat luxurious notion that society should provide a cloister for thinking. During their period of residence at a university, students have been expected to remove themselves from society. While the classical university has accomplished far more than debate on how many angels could dance on the point of a pin, it has emphasized knowledge for knowledge's sake, disciplinary learning for the discipline's sake, professional knowledge for the professions's sake, and autonomy from the rest of society.

Today the needs are for a university that is more fully a part of society, even while retaining its autonomy and academic freedom. The needs are for a university that has a sense of social responsibility, that has a problem orientation to its curriculum, that is concerned with future time, and that seeks the integration of knowledge. Let us examine each of the four elements of a university academic plan based on environmental education.

First, given the environmental crisis that is engulfing the world, there is a need for universities with academic plans based upon a philosophy of social responsibility. Because of the explosion of knowledge, every university and every scholar and student must be highly selective in the areas of knowledge in which they specialize. Rather than having such a selection made on the basis of pure institutional or personal whim, or on the basis of disciplinary considerations, it would be preferable to make such a selection on the basis of a sense of social responsibility.

A philosophy of social responsibility requires a decision on a student's part that he has a stake in the world, and that he is going to use his opportunity of acquiring knowledge to prepare himself to helping make the world a better place. Similar decisions are required of the scholar and the university. This does not mean an endorsement of any particular political movement. It does mean that universities must identify elements of relevance, and incorporate them into a university's mission and curriculum. A university can help make knowledge socially applicable and assist the student and the larger community in acquiring skills in how to bring about social change. A university education can be made relevant, can be made an experience in social responsibility, if we in higher education wish to take appropriate initiative.

A university should offer opportunities to students to heighten their awareness of all kinds of environmental concerns - cultural, social, and biophysical. While institutions of higher education must be careful not to resort to indoctrination techniques, it is their role to provide opportunities for students to rethink the value bases of their lives and their society. And it is well to remember that such cardinal virtues as love and peace are not attainable if we do not have a substantial quality of life in this world. It is important that all persons find much of their identity as human beings in their relations with other human beings. This is not to argue that the group or the state is always superior to the individual. It is to insist that no human being can find his own identity in a meaningful way separate from his relations with other human beings.

Second, environmental education is fundamentally problem-oriented education. It suggests, in its broadest sense, that a student, a scholar and a university should select courses and points of emphasis related to certain kinds of problems in which they have a particular interest. These problems could be of a biophysical nature, such as the world's severe shortage of energy. They could relate to unrecycled waste, or to problems of pollution in general. The physical quantity of non-renewable resources could pose challenging questions, along with the depletion rate. The impact of man on the entire non-human biophysical environment could provide a framework of study and analysis that would be rewarding. There are increasing concerns relative to water quality, air quality, and soil quality that need to be addressed by professor and students alike. In the social environment sphere, human living environments need to be studied. In this urban world, many students and professors could usefully devote their energies to relating knowledge to creating better home environments, better recreational environments, and better work environments. The relationship of the economic and the political systems to human living environments is central. In regard to cultural environments, again the professor and student are presented with many possibilities. There is the potential threat of cultural homogenization both within and among countries. Regional and ethnic art, music, and drama are increasingly under attack by forces making for sameness in the world and in particular societies. But whatever the focus, there are plentiful opportunities for problem orientation in any of the arts and sciences and the related professions. A problem orientation will give a new meaning to learning, and an enhanced motivation for learning. In turn, the role of universities will be strengthened in the estimate of students and even more important, in the estimate of the larger community.

Third, a new time perspective - future time - needs to be adopted by universities. Historically, universities have tended to emphasize the past. They have prided themselves on being depositories of knowledge In fact, the very idea of a university and a university library brings visions of old manuscripts and dusty books of many years of age. Knowledge of the past will always be important, of course. But the past must be studied principally for the lessons it contains for the future. In truth, futurism should become the concern of all branches of knowledge and of most courses. In addition, courses specially oriented to the future should be developed. For example, a university might offer a seminar in a student's last year in which the student would be required to project the dimensions of a problem and its alternative solutions over a twenty- or forty-year period of time. Solutions to problems are not likely to be adequate if only the present or the near future is considered. In any event, the real potential of environmental education at a university level can be reached only within a context of future time.

Fourth, integration of knowledge as it is applied to particular problems is a requisite of environmental education. There is a resurgent need to permit and encourage both student and faculty member to relate any and all aspects of knowledge to environmental problems. We have heard many words about multidisciplinarity, interdisciplinarity, and transdisciplinarity. In fact, there is nothing wrong, fundamentally, about disciplinarity. All of these aspects of knowledge can be related to environmental problems. Thus, one could imagine elements of all disciplines being applied to environmental problems in one or another parts of the curriculum or student's learning experience. In addition, there could easily be multidisciplinary and interdisciplinary courses applied to the same range of problems. The concept of integration of knowledge is fundamentally a concept that requires openness of approach to a problem. It does not deny the validity and usefulness of disciplinary knowledge. Nor does it embrace interdisciplinarity for interdisciplinarity's sake. Rather, it requires a reliance on whatever particular areas of knowledge are useful and valuable to the problem objectives at hand. Of course, with this as an objective, much greater emphasis will have to be placed on interdisciplinarity than has been true up to now.

A university which adopts an academic plan based on social responsibility, problems orientation, future time, and integration of knowledge is fundamentally committed to educating its students in problem solving. Over the years universities have done rather poorly in developing the problem-solving abilities of their students. Normally there are relatively few opportunities for students to learn how to identify problems, how to develop alternative solutions, and how to take effective steps toward implementation. Social change is often thought of as something that can be prescribed, something for someone else, rather than something that is evolved and personally experienced, and even personally painful. Social change is often discussed in the abstract, but seldom is there a concerted attempt to develop instrumental abilities among the students. An important factor to keep in mind is that instrumental abilities are needed among all kinds of people, regardless of their position in society, their field of knowledge, or the problem with which they are concerned. Instrumental abilities are needed just as much among the physical sciences and the biological sciences as they are among the social sciences and the humanities. They are needed among professionals, among specialists, and among generalists. Every student is a potential decision-maker. If students are to become effective participants in community betterment in years to come, they should be permitted and encouraged to enhance their problem-solving abilities while enrolled at universities.

Problem-solving and instrumental abilities can be strengthened in many ways. There must be flexibility in the content of a university education, so that each student can adapt the curriculum to the kind of problem focus he or she would most like to pursue. There need to be opportunities for students to take initiative in their own learning, just as they would take initiative in regard to problem-solving at a time after graduation. There should be opportunities for internships and special projects in the community, focused upon social change and environmental concerns. Such experiential education underlines the fact that not all knowledge is obtainable on campuses of universities. Community members must be involved with professors and students if off-campus experiences are to be effective. In this way students can learn that most social change takes place as a result of cooperation, not confrontation. Environmental education should be multi-cultural, since the solution to environmental problems may vary culture to culture, and certainly ways of implementing solutions will vary culture to culture. Furthermore, environmental concerns are system concerns. In our world, everything is connected to everything else. These interlocking systems must be understood and must be changed if we are to make progress in quality of life. Cybernetics becomes of great concern to those who would emphasize environmental education.

Thus environmental education is a philosophy of education. This philosophy provides clear guidelines for those who would introduce change in universities. These guidelines are applicable whether environmental education is to be introduced throughout an entire university or in just part of a university. They are applicable whether the university, institute, faculty, or school is old and established or new and unstructured. They are applicable whether the approach is specialist or generalist, avocational or professional. And they are applicable regardless of the academic area, disciplinary field or subject matter concerned.

The need for environmental education has never been greater. And it is a worldwide need. The recognized leader in this worldwide movement is the Organisation for Economic Cooperation and Development. For more than four years OECD, through the Centre for Educational Research and Innovation, has been actively encouraging universities around the world to be alert to opportunities and responsibilities in environmental education. Its conference at Nice in September 1970 was an initial exploration into the nature of interdisciplinarity. It was the consensus of that conference that interdisciplinarity was an important trend in higher education. However, the trend could be neither condemned nor endorsed, the conferees felt, apart from the use to which interdisciplinarity was to be put. Since OECD is essentially a problem-oriented organisation, it was not surprising that its next step was taken promptly. In April 1971 it sponsored a very productive seminar on environmental education at Tours. Essentially, the Tours seminar identified much of the ideological or philosophical base of environmental education. It also made important contributions to defining and delimiting the concept of environmental education. Through the OECD publication programme, the results of these efforts became widely known. And now, three years later, we have yet another initiative by OECD. This time the preparation for the conference has been preceded by a set of case studies and surveys. Conference participation is broader than ever before. The emphasis is upon actual experience with environmental education, and problems of implementing it still further.

The Member countries of OECD bear a special responsibility in regard to environmental education. They are the more advanced industrial countries. They have complex environmental problems, of a kind that other countries will soon experience. And they have substantial systems of education, which have developed over many years. These systems in turn have influenced and are continuing to influence educational patterns in many other countries around the world.

Up to now the systems of higher education in the various OECD countries, while having many differences, have essentially shown similar tendencies. Almost without exception, the bulk of institutions of higher education in these countries have followed the classical model of higher education. In these universities, professors are primarily identified by the disciplines or professions to which they belong. The emphasis is on the accumulation of new knowledge and the acquiring of knowledge for knowledge's sake. In the last few years, a number of Member countries have created new universities. Some of these have become experimental universities, and have not followed the classical model. Several of them have become explicitly oriented toward environmental education. In still other instances, there are particular faculties or institutes or schools of much larger universities that have become the experimental models in environmental education.

Thus it is apparent that we in environmental education have made some progress. We started some years ago with discussions of the environmental crisis and with observations on interdisciplinarity. We then proceeded to define the concept of environmental education and identify warp of its initial application. Now, judging from the papers of this conference, we are concerned with its further implementation and with its status within our universities - hopefully a co-equal status.

Have we then come to the end of the line ? Are we now attaining our ultimate goal ? Do we come to Rungsted to celebrate the last conference devoted to the development of environmental education for OECD countries ? What is, and will be, the significance of the Rungsted conference ?

I believe that Rungsted is not the conclusion of our efforts. Rather, it represents a significant midway point in a long-term effort to reform higher education. It signifies the introduction of environmental education into at least one of the curricula of at least some universities in each of the OECD countries. And the conference has resulted in the description and analysis of these programmes and the identification of the conditions under which they can be introduced and can prosper. That is no small accomplishment. We have a right to a certain satisfaction.

There remain three important tasks ahead,however. First,environmental education is in danger of being restricted by being viewed either as just another general education course (another course "add-on"), or as another department, institute, school, or faculty in competition with other departments, institutes, schools, or faculties. We must keep our eyes on the long-range objective, namely, that environmental education should pervade all kinds of curricula,all kinds of departments, institutes, schools or faculties.

Second, up to now we have been concerned with individual universities and their curricula : the time has come when we should focus our attention on systems of universities. Each of our countries has such a system or a series of systems. Each system contains several or many universities. Within each of these systems, will the pattern of the last five years prevail, with the classical model of universities continuing to dominate, and environmental education retaining a small experimental - and hopefully, co-equal - status, here and there ?

Or, has the time not come to remove the "experimental" label from environmental education ? Given our substantial experience with it, and given the urgency of world environmental problems,should not environmental education be a major thrust of each higher educational system ?

My own response to these latter questions is definitely in the affirmative. It is time that OECD Member countries rethought the principles underlying their systems of higher education. If environmental education is to assume its proper and justified role, the classical model of a university should become the exception, rather than the rule. Environmental education, broadly conceived as a particular kind of approach to education, should predominate in the vast majority of universities and university curricula. Most universities and university curricula should move in its direction.

A third task lies before us. Environmental education is problem-oriented education. The study of environment must not be artificially separated from the study of other pressing problems of the world. The problems of human conflict and cooperation, the problems of human identity, the problems of econo -

mic development - these are a few of the countless areas of human concern. And environment is related, but perhaps not always central, to each of them.

We in environmental education have an opportunity to give leadership to problem-oriented education, and not just to a narrower environmental education. This is a necessary next step if the term "environmental" is to retain a broad meaning. More important, the ultimate significance of the environmental approach to education lies in such a course of action - in relating environmental factors to the other problems of the world.

Thus after Rungsted we will still have important unfinished work to do. The goal is to work for systems of higher education in each of our countries in which problem-oriented education is the normal pattern in the majority of universities. As a supplement to this normal pattern, one or two universities, or supplemental parts of universities, should be expected to retain the classical model and emphasize basic research and knowledge for knowledge's sake. One or two universities, or supplemental parts of universities, should be boldly experimental. They should move on beyond the confines of problem-oriented or environmental education as presently conceived. But each system in the main should emphasize problem-oriented education in most of its universities.

This is an ambitious goal. It is not attainable quickly or easily. But nothing short of an ambitious goal is adequate to the broad educational needs of our problem-beset world today.

ADDRESS BY MRS. TOVE NIELSEN, DANISH MINISTER OF EDUCATION

Your Royal Highness, Mr. Secretary-General, Ladies and Gentlemen,

On behalf of the Danish Government it is a great pleasure for me to welcome you to Denmark to this conference of Environmental Education at Post-Secondary Level. We are flattered that the OECD has chosen our country as a site for this very important meeting, and I feel convinced that the results of this conference will contribute to enlarge our efforts in the field of environmental education in the future.

All over the world the tendency towards a closer relationship between education and the community is a predominant feature and thus the emergence of environment as a public issue has been reflected also in the rapid growth of the environmental programmes in education.

Environmental education being of an international character makes a wide international cooperation natural and essential. In view of the previous conferences at Nice and Tours, and their success, and bearing in mind the great work which the OECD/CERI has carried out within this field, I want to express my appreciation for the helping hand which is thus stretched out to national authorities in order to facilitate their efforts in the struggle for a better environment, and for the aid the environmental programmes at our universities may receive from the results of this and the two above-mentioned conferences.

We all feel that the demands for an improved society are growing in these years and it is my hope that the achievements of your work in the coming days will be a step towards this goal.

With these few words I wish all participants a successful conference and four days of hard work.

REPORTS AND RECOMMENDATIONS OF WORKING GROUPS

SUMMARY OF RECOMMENDATIONS

Responsible authorities in OECD Member countries are urged to :

i)- encourage the acceptance and development of environmental interdisciplinary academic units which would provide appropriate training for the specialists and generalists, professionals, educators and decision-makers as defined in the reports and recommendations of the Working Groups ;

ii)- support the establishment of interdisciplinary environmental research institutes as distinct from multi-or pluridisciplinary institutes which may not have integrated approaches towards the design of research or synthesis of results. These interdisciplinary institutes should be linked with the teaching institutions and should receive special allocations of resources for their activities ;

iii)- encourage and support the establishment of National Councils of Environmental Education to promote environmental education at the preprimary, primary, secondary and post-secondary levels ;

iv)- develop the principle of recurrent education - discussed in previous OECD publications - as a long-term strategy for the future of environmental education. In the immediate future, educators, professionals, and decision-makers should have better opportunities for retraining and for expanding their environmental knowledge and skill. This could be achieved by developing a flexible organisation for both systems of education and work.

Academic institutions that engage in environmental education are urged to :

v)- be fully aware that such interdisciplinary programmes are believed to be best implemented through a problem solving approach, issue-oriented and system-oriented case studies, team teaching and practical field work ;

vi)- assure leadership roles in establishing forums to formalize communication between interdisciplinary teams and decision-makers on community and regional environmental problems.

Organisations involved in international environmental research and education are urged to :

vii)- continue and expand the coordination and cooperation of their work in order to avoid unnecessary duplication of efforts.

viii)- maintain a flow of information on environmental education and research, with particular respect to manpower, resources and institutional facilities.

Working Group N° 1 :

ENVIRONMENTAL EDUCATION FOR SPECIALISTS AND GENERALISTS

Chairman : P. Jones, Canada

Rapporteur : P. Laconte, Belgium

1. The members of the Rungsted Conference emphasized the priority need to promote simultaneously :

   a) the training of a larger number of specialists in the natural or human sciences able to treat environmental problems.

   b) an ability in these trainees to communicate adequately with other specialists whose work has an environmental impact.

2. This requires that in the various disciplines and at the various levels of university and post-university education a training in the field of environmental action and interdisciplinary communication be promoted. In order to accomplish this objective we specifically recommend that :

   i)- Each OECD Member country evaluate how many disciplined specialists should receive environmental training and how many people might be required of a general natural or social sciences or humanities background with emphasis on environmental quality over the next 15-20 years. These evaluations should recognise the consequences of the Member country's environmental and science policy and provide a basis for the development of national environmental education policy at the post-secondary level.

   ii)- Member countries encourage the development and acceptance of Environmental Academic units at some of their post-secondary institutions. In order to ensure the adequate development of these interdisciplinary units it is further recommended that special additional financial resources be allocated specifically to such units to maintain their interdisciplinary balance.

In some cases inter-institutional (more than one university) educational units may be desirable to optimise the use of expertise and human resources.

iii)- General overview courses be made available to all students early in their studies. These courses should provide a conceptual framework being both of value in itself and a point of departure for further studies of environmental problems.

It is recognised that a broad variety of subject matter should be presented including the natural and social sciences, law and economics as well as the humanities.

iv)- While every effort should be made to create a variety of educational programmes there will still be a need for training in the specialised disciplines that make up Environmental Sciences, natural and social sciences both pure and applied, and humanities.

Recognising the difficulties these disciplines face in tackling many environmental problems we strongly urge that special educational and other efforts be made to facilitate communication between experts. This is a prerequisite for that team work which we see as essential for the solution of many environmental problems.

v)- Each OECD Member country should encourage and support the formation of a national council for environmental education and research centres (faculties, departments, institutes, etc.) for the purposes of exchanging information or perhaps pooling of resources for the national good. Future international meetings might be planned to bring such national councils together to exchange information on an international level.

vi)- While recognising its specific terms of reference, this Working Group nevertheless urges Member countries to emphasize the world-wide significance of environmental education. This should be in terms both of optimising the management of resources in industrialised countries and providing the basis for third world industrialisation with minimum environmental impact of world-wide consequences.

Working Group Nº 2 :

ENVIRONMENTAL EDUCATION FOR PROFESSIONALS

Chairman : G.H. Sewell, United States

Rapporteur : P.F. Regan, OECD

EDUCATIONAL POLICY

1. To improve the environmental component of professional education in existing and planned programmes, goals should be formulated (and, where possible, implemented) at a national level. Previous educational preparation and future employment opportunities for those qualifying in the programmes should be considered within this planning process.

DEFINITION

2. In the context of this statement, a professional is defined as an individual who (a) bears independent analytical and judgmental responsibilities, and (b) possesses a qualification, usually approved by some regulatory body or recognised educational institution. A post-secondary education is normally implied.

NECESSARY COMPONENTS

a) In general, all professional education should include some multidisciplinary orientation, which is the essence of an environmental perspective. This orientation is necessary to ensure an adequate scope of subject concern and the ability to communicate with other professionals.
b) For professionals with responsibilities significantly involving the environment, the educational process should also include extensive, in-depth training in a subject or skill related to the control of environmental problems.

c) If the professional is to be given responsibilities for co-ordinating, managing, or synthesizing the efforts of other professionals in the environmental field, a third educational component consisting of broad but rigorous training in environmental systems is required.

CONTINUING AND RECURRENT EDUCATION

3. Educational opportunities for practising professionals should exist to :

a) Provide recurrent education in new fields of environmental specialisation.
b) Refresh earlier educations becoming out of date through technological obsolescence.
c) Provide the broad environmental orientation necessary to the environmental co-ordinator or manager.
d) Retrain teachers.

EDUCATIONAL TECHNIQUES

4. Extensive use of problem-oriented case studies as a technique of interdisciplinary education is encouraged. Institutional flexibility and innovation, however, is needed to cope with the evaluation and guidance of students and to provide adequate instruction.

5. Systems analysis and synthesis is an essential aspect of environmental teaching. There is a need to emphasize four professional considerations :

i)- Social and human (including involvement of the public)
ii)- Ecological
iii)- Management and Information systems (including the decision-making process)
iv)- Technological.

INTERNATIONAL RESPONSIBILITIES

6. International agencies are encouraged to maintain a flow of environmental information for professionals. Both short-range developments, such as new technologies or threats, and long-range trends, such as resource limitations, are involved. The exchange of professional expertise across national and geographical borders also enhances abilities to cope with environmental problems. Agencies should also promote the development of environmental education at all levels and, in particular, for professionals.

ANTICIPATED PROBLEMS

7. In implementing these recommendations, a set of institutional obstacles are recognised :

a) The likely reluctance and, in many cases, inability of decision-makers to adopt these proposals.

b) The difficulties in disseminating the necessary information in a form acceptable to decision-makers.

c) The inertia of attitudes in professional and academic institutions.

d) The difficulties of implementing mid-career environmental education for managers because of occupational pressures.

e) The difficulties in defining "environmental sciences" and the vagueness of environmental responsibilities.

f) The shortage of appropriately qualified teachers.

Working Group N° 3

ENVIRONMENTAL EDUCATION FOR EDUCATORS

Chairman : J. Huble, Belgium
Rapporteur : T. Davey, United Kingdom

1. This working group included both those who had taught in schools and are now involved in teacher education and others interested in this field because some of the students attending their courses will become teachers. The group did not have experience of all patterns of teacher education found in the countries represented. In many cases the courses discussed had relatively few students and had been in operation for a very short time.

2. The intentions of such courses were discussed. Some placed emphasis on dealing with problems arising in the environment (complex environmental situations) whereas others used environmental situations as illustrations of more general themes, concepts and methods of study. Both groups realised that no course can be organised around chance environmental incidents ; what is essential is that from work focused on particular environmental problems, generalisations and systematic schemes should be drawn which can then be applied to other situations. No consensus on the organisation of courses could be achieved in the group but there was general agreement that it is useful to include development of a systems approach.

3. Environmental education must include some consideration of value judgments. An interdisciplinary approach to the study of environmental problems facilitates this. No one wished to inculate particular values but rather to provide opportunities for the development of an adequate personal value system. This kind of education requires that the initial and recurrent education of teachers should lead them to examine and to develop their own value systems. At the same time, it is necessary to help these teachers to produce learning situations that foster the same kind of developments in their pupils. Useful techniques for this kind of education might include choosing examples with value-laden content, using real-life situations and exercises involving role-playing and simulation. In addition an examination of the developments in moral education might be helpful. Always, the age and so the readiness of the pupils for a particular kind of education must be considered.

4. Interdisciplinary teaching, which often involves looking at particular situations from many angles, was favoured. Besides fostering value education, this kind of approach ensures that pupils gradually develop a scholastic understanding of the environment. Nevertheless, interdisciplinary teaching has been found to pose severe problems. Implementation is hindered by the insecurity of individual teachers and by organisational constraints. Although it was felt that all teachers should receive some environmental education, at present it is likely to prove necessary to use those specialised in separate disciplines in providing this. Teachers who are required to take part in interdisciplinary teaching need to be given time for planning their work and opportunity for additional training. It is also useful to be able to call upon outside experts. Those who are most successful are likely to be skilled in asking questions to stimulate discovery learning and also able to accept a less well-defined authoritative role than the teachers who see themselves as instructors.

5. All innovations introducing environmental education into school involve a sympathetic attitude from educational administrators, from the school principal and from the teachers themselves. It is necessary to ensure that those at all levels of the educational system gain some insight into environmental education. As this area involves the handling of sensitive issues not all teachers will feel competent or will find the task attractive.

RECOMMENDATIONS

i)- Opportunity for environmental education should be made available for those involved at all levels in school education - administrators principals of schools and teachers. All teachers should receive some environmental education while undergoing training. At present it is likely to be necessary to use experts from separate disciplines to provide this.

ii)- It should be recognised that teachers involved in environmental education need to be given time to prepare and to consult with colleagues. Their teaching hours should be reduced and it is urged that finance should be available to make this possible.

iii)- Environmental education involves the development of personal value systems but not the inculcation of particular values. Teachers undertaking environmental education should be encouraged to examine and develop their own values and should be shown ways of leading to similar developments in their pupils.

iv) - Environmental education should entail interdisciplinary teaching since this leads both to an appreciation of interrelationships and provides good opportunities for examination of values.

v) - Courses for teachers of environmental education should include consideration of the specifying of objectives, the design of work suitable for particular age groups and pratice with a range of appropriate teaching skills. These include the organisation of field-work, groupwork, team-teaching and problem oriented approaches.

vi) - Research should take place on the problems of interdisciplinary teaching which include the personal insecurity of teachers and the conditions that permit or prevent co-operation of teachers and team-teaching.

vii) - A detailed programme of investigation of the effectiveness of environmental education for teachers should be instigated. This should attempt to evaluate the effectiveness of present teacher training programmes and the implementation of change that such training initiates.

viii) At the same time, it is necessary to discover how effective are particular attempt at curriculum change and what factors operate to ensure effectiveness.

ix) - Study should be made of the desirable balance and organisation of contents within courses of environmental education, and particularly of the relationship between natural science and social aspects and between local and global emphasis.

x) - There is at present no shared language to provide a common framework for discussion of the objectives involved in educating teachers in this area, and this should be given early attention.

Working Group N° 4

ENVIRONMENTAL EDUCATION FOR DECISION MAKERS

Chairman : M.G. Royston, CEI

Rapporteur : A. Brownlea, Australia

PREAMBLE

1. The target group of decision makers, in this context, has the power to make decisions affecting significantly the quality of life and environment of many people external to their own group. It includes politicians, civil servants, industrialists (including bankers, real estate developers, speculators), trade union groups, and, to a larger extent, citizens' action groups.

2. The decision-making process may operate in ways inimical to environmental well-being : unshared information,undisclosed alternatives, unconsulted viewpoints, unaccountable actions,inaccessible people, ineffectual involvement, covert persuaders, limited data base, operational time constraints, unclear responsibilities and boundaries,inability to remake decisions, inadequate social impact assessment, bypassing government processes by industry, unwillingness to listen and an inability to be heard, inability to learn from mistakes, political sensitivities closing out review, ego involvement.

3. High levels of literacy, income and technological development are not the necessary and sufficient conditions to avert an uneven and inequitable incidence of environmental deterioration and social disamenity. Furthermore, low levels of literacy and technological expertise do not, in themselves, preclude social and environmental improvement. The crucial parameter is the quality of the relationship between the decision makers and the people - if a marked gap exists, then environmental and social problems will inevitably arise. That gap,may be a sensitivity gap, an information gap, an accountability gap,and so on.

4. A prime objective of any environmental education activity for decision makers should be to improve the quality of the decisions made in such a way that would ensure lasting reductions in the total burden of environmental deterioration and social disamenity, as well as an amelioration of the inequities that generally accompagny them.

5. The variety of environmental education activities reflects an adjustment to the milieu in which the decision-making takes place. The activities range from seminars to short courses and to post-graduate training for some, and may involve single types of decision makers or mixed groups of various kinds of decision makers, and may take place in a tertiary institution (college, institute, university), in a field situation, or combinations of these. The programmes may vary in the level of technical competence required, but will generally elaborate the ways in which environmental problems arise, the methods of environmental problem solving, and the sources of information needed.

6. The full costs and the effectiveness of each environmental education activity for decision makers have to be evaluated. An effective course may generate more work for the tertiary institution. While a small university shares a custodial responsibility for the future of society, its community involvement should in no way compromise its research base and independent integrity or its scholars. The goal of community involvement is, in fact, a better and more effective university and not its conversion to a vehicle for achieving the aspirations of powerful decision making groups.

RECOMMENDATIONS

i) - That each Member government of OECD should establish a National Council on Environmental Education. This Council would develop curricula in environmental education sensitive to its national cultural setting, and responsive to its national needs. A first task might be to develop a programme for decision-makers.

ii) - That the approach to the educational task should be problem issue- and systems-oriented, so that decision-makers may come to understand the theoretical bases and concepts of environmental science, the nature and evaluation of the consequences of decisions and the decision-making process (especially as regards impact assessment and cost-benefit analysis), initially on local, then regional, and subsequently global scales, and in societies of varying cultural ideologies and settings. Among the significant outcomes of such an approach would be an understanding of the basic laws, diversity, and constraints inherent in ecosystems, insight into how and why environmental problems have arisen, and competence in the methodologies of environmental problem solving, including systems analysis and problem definition.

iii) - That appropriate institutional structures e.g. Environmental Forums, be established in OECD Member countries to formalise communication between scientists and decision-makers on community and regional environmental problems.

Working Group N° 5 :

THE SUBJECT CONTENTS OF ENVIRONMENTAL EDUCATIONAL PROGRAMMES

Chairman : O. Francis, Canada

Rapporteur : S. Struwe, Denmark

1. It was recognised that the specific content of individual programmes would vary widely depending on the major objectives and orientation of programmes and their level within post-secondary institutions. They should reflect broad societal needs and job opportunities available to graduates as revealed through manpower surveys, job analyses, and opportunities created by new laws and government policies.

2. The group agreed, however, that environmental studies programmes have a need for an introductory overview course and a more advanced integration course as part of any overall curriculum that includes training in particular disciplinary fields.

3. The appropriate approach to the overview course would be a problem-oriented one. Problems would be analysed through a system based on reasoning that would examine historical, biophysical, socio-economic and technological aspects of problems and possible solutions.

4. The advanced integration course would stress research methodologies, systems analyses, and team work on selected research problems in applied studies such as environmental impact analyses. One main purpose of the advance course would be to provide experience in team work to people already trained in different disciplines and professions.

5. The group agreed that an annotated bibliography from present courses would be of very great use for assisting in the selection of topics and methods in environmental education. Also a newsletter dealing with the content of these courses would ease the spread of ideas and contact between teachers. This need is particularly strong for the introductory overview course.

Working Group N° 6 :

TEACHING AND TRAINING METHODS

Chairman : P. Schneider, Germany

Rapporteur : M. Vosman, Netherlands

1. The field allocated to this working group was so broad that we had to restrict ourselves to certain aspects only. Methods in different countries are so diverse that it was difficult to give recommendations for all. The case studies and other documents supplied by OECD (especially Document 2) were most helpful in our discussions.

2. Each teaching method has advantages and disadvantages. One has to arrive at an appropriate balance between them for an optimum course, bearing in mind the different needs of various groups of students.

3. In general we would favour teaching and learning methods that actively involve the students rather than those where the student is merely a recipient. Such activities presuppose high staff/student ratios, flexible organisations and necessary resources.

4. In some circumstances we feel lectures to be appropriate. Their particular value is in the inspiration they can give and the panorama they can present highlighting significant items. It is envisaged that courses will not be dominated by lectures, and that lecture sessions will be integrated with other activities such as seminars and discussion groups.

5. Fieldwork is recommended because it confronts the student with an actual problem that can be analysed and so can lead to a better ability to pose useful questions and to an understanding of the process of decision-making. It is one of the ways to expose students to a whole problem. It prevents them from being content with too simple a solution, thus minimising the likelihool of reductionism. Also the student can recognise his own limitations in this kind of study and can reconsider his own attitudes and values. Finally, he is enabled to discover the needs for diverse skills of communication.

6. Simulation and role playing are thought to be necessary because they give opportunities for increased understanding of many viewpoints and the operation of natural systems. They also provide possibilities for examining problems on a variety of scales and levels and for practice in decision-making and enhancing personal concern.

7. The breadth of environmental education and the variety of experience of students entering courses leads to problems. This requires the development of techniques for diagnosis of individual weaknesses. It is necessary to produce individual learning programmes to help students to rectify these shortcomings. Such programmes would be economically viable if they were used over a number of years or shared by several institutions.

8. Communication : It is desirable in such a diverse field as environmental education that a variety of methods of communications and vocabularies, codes and symbols be used in teaching and expected of the students. These include verbal, graphical, numerical, statistical and systems languages.

9. Team teaching : The breadth of environmental education is such that team teaching is essential. Retraining of teachers for working in teams is likely to be needed.

Working Group N° 7 :

THE RESEARCH BASE REQUIRED FOR ENVIRONMENTAL EDUCATION

Chairman : D. Kuenen, Netherlands

Rapporteur : P. Trehen, France

RESEARCH IN THE ENVIRONMENTAL FIELD

1. This research is of two types :

   i)- Long-term research : This deals with the functioning of natural and humanised ecosystems and defines the varying degrees of inter-relationships between them and human activities, and the impact of these ecosystems on human life.

   ii)- Research into local real-life problems in their environment.

2. These two tentative definitions give rise to the following important observations :

   - Both types of research must be interdisciplinary and this presupposes increased liaison between those doing it, the majority of whom must also be teachers.
   - Interdisciplinarity must be based on integrating principles which may be related to the global systems approach. Some aspects are quantifiable, for example, resources and transfers of energy or cycles of elements. Others - for example certain human aspects - are not, or not yet, quantifiable.

CONDITIONS FOR ENVIRONMENTAL RESEARCH

3. Besides the university centres, there will have to be pluridisciplinary science institutes, independent of the universities, for teams working on general themes relating to one or other of the two research fields described above, and composed of researchers of very diverse origins. Their job must be to ensure continuity in research for which the universities cannot take on the responsibility, but they will function in close liaison with the university centres. The

way these teams are structured must not depend on the usual administrative procedures, but must be allowed to come about by a process of crystallisation. The team will develop by converging on already existing nuclei doing research on such matters as local problems of real life.

4. In associating themselves with these teams, researchers will undertake to make this their principal task. These pluridisciplinary science institutes will rely, moreover, on institutes or specialised teams which by their influence enable these specialists to keep in touch with the current state of knowledge in their special fields.

5. It is necessary to emphasize how difficult it is at present to integrate the human aspects with the aspects relating to the exact sciences.

6. The new conception of work within these teams is based on two main ideas : acceptance of the existence of different levels of intervention in a piece of research, and willingness to work as a team. This new approach should also make it possible for researchers to become aware of the fundamental principle of the developing nature of research fields brought about by the general advance of human knowledge on a broad front. It can be summed up in a few basic principles :

- unity of place ;
- coordination of research ;
- each researcher must remain a member of the group of his original discipline ;
- the research currently being done becomes environmental research as soon as activity at each level is fitted into the framework of the more general problems.

INTEGRATING RESEARCH WITH TEACHING

7. In integrating research with teaching, the responsibilities of teacher-researchers for the transmission of knowledge must not be forgotten. Integration constitutes an awakening, but it cannot in any way replace the acquisition by the student of knowledge which forms part of the inherited sum of human knowledge.

8. Students must be made to participate in research, but limits must be set to such participation :

- the immediate aim is to increase the student's experience rather than add to his knowledge ;
- to begin with, such research should preferably be oriented towards practical problems.

9. It is essential to make a good match between the level of the student and the level of research. If this match is badly made, the result will be that the student will become accustomed to superficiality and will get a false idea of the nature of research. The choice will also depend on the personality of the student.

10. Lastly, integration implies the development of pedagogical research.

Working Group N° 8 :

RECURRENT EDUCATION

Chairman : J. Bussanyi, United Kingdom
Rapporteur : M. Willey, United Kingdom

CONCLUSIONS AND RECOMMENDATIONS

1. The group felt that the principle of recurrent education as already discussed in previous OECD publications should be adopted as a long-term strategy for the future. This strategy entails the modification of existing educational structures by the development of a system whereby all individuals can return to the educational process at appropriate periods throughout their career. It is necessary because of the changing needs of individuals to fit into a changing society and because of the rapid advance of knowledge, and it provides the means for further education, re-education and re-training, and updating.

2. The implementation of such a strategy involves numerous problems whose solutions must be elaborated according to the conditions obtaining in each country. The group felt the following problems and aspects to be particularly important :

a) Mechanisms for release from employment to enable persons to attend courses. Whatever the details of mechanisms elaborated, they should form a system whereby the individual should not be constrained by his or her employer to attend a certain course but should have the right of free choice. Further, the right to have time off should be embodied in appropriate legislation such as is already evolving in various countries.

b) Mechanisms for financing recurrent education.

c) Selection of subject matter, with particular attention to the needs of the target groups.

d) Organisation of courses : arrangement of subject matter, options, duration, time-tabling, use of facilities provided by industrial and other establishments.

e) Recurrent education should not be confined to universities but should involve also other educational establishments, some of which already have considerable expertise in the organisation of part-time education. But universities should play an active teaching and co-ordinating role.

f) The strategy implies a re-appraisal and the development of a new partnership and system of interaction between universities, other educational establishments and various sectors of the outside world.

3. In the field of environmental recurrent education in particular, the group felt :

a) That courses should be run to achieve two major objectives :
   i) awareness and a general overview of environmental issues and problems ;
   ii) expertise in particular environmentally relevant fields.

b) That three target groups should be particularly catered for, which in the short term might be given the following priorities :
   I. People in positions of management and decision-making.
   II. Specialists/professionals with major environmental commitments.
   III. The general public.

For category I the need is for awareness and overview courses, and in some cases for expertise courses.

For category II expertise courses are required which should however include a considerable element of interdisciplinary project work to broaden their activity and enhance contact with other specialists/professionals. As citizens, people in this category also require awareness and overview courses.

For category III awareness and overview courses are the requirement.

Project work is important also for categories I and III.

c) That certain special research needs exist, especially into :
   i) the impact and usefulness of courses ;
   ii) procedures for assessment of adult students' work especially in view of the diversity of and within environmental courses offered ;
   iii) pedagogical methods for heterogeneous groups.

d) that the mechanisms and problems of the implementation of recommendations require elucidation and that the idea of national Environmental Education Councils should be supported and further developed.

Working Group N° 9 :

INTERNATIONAL CO-OPERATION IN ENVIRONMENTAL EDUCATION AND ITS RESEARCH BASE

Chairman : G. Sewell, United States

Rapporteur : J. Celecia, Unesco

In the context of global communality, international co-operation in environmental education and its research base must be established to fulfil the following needs :

1. Defining problems, potentialities and standardizing methods

Environmental problems or potentialities are often not easily distinguishable within a single nation with a relatively homogeneous economy, physical conditions, and culture. International comparisons permit these problems or potentialities to be more clearly defined and, therefore, have a place in teaching, research, and decision-making.

Furthermore the comparison of results at international levels is often hindered by the diversity of methods and procedures employed.

2. Transfer of knowledge and skills

International transfer of environmental knowledge and skills will enhance the ability to cope with common environmental problems. Furthermore, matters relevant to curricular innovation, development of methods in environmental education and related areas should be included as an integral part of information flow and exchange.

3. Solving international pollution problems

Pollutants do not respect national borders. Some degree of international co-operation in fostering public awareness and research is necessary to achieve control measures.

4. International training of environmental students

Opportunities should be developed to permit students to benefit from participation in educational and research programmes outside of their own countries. Such training should be adequately credited.

5. Research and evaluation of economic and technological assistance

OECD Member countries, when granting or extending economic or technological assistance to other countries, should investigate and assess the environmental consequences of such aid. They should further consider providing recipient countries with appropriately trained personnel to protect those environmental aspects characteristics they themselves consider of cultural and social value.

6. Co-operation with and between international agencies and joint provision of services

The consideration of international ventures calls for the identification of all organisations already involved internationally in environmental research training and education. It should further acknowledge their existing and future projects and programmes. Moreover there should be an attempt to achieve co-ordination and co-operation between agencies with a view to avoiding duplication of efforts.

The OECD can play a further co-ordinating role in these international ventures. It should develop an administrative structure which would serve three specific functions. First, to co-operate with other international agencies to inform Member nations of international needs in the areas of environmental research and education. Secondly, the Organisation should inform potential user groups about the human and technical resources of the education and research agencies. Finally, in order to assist both the research/education agencies and the potential user groups, it should identify facilities, manpower and financial resources that may be used to solve international environmental education problems.

It is also suggested that the services and activities identified in the preceding paragraph should involve as many institutions as is practical. The only limitation should be that the co-operating university should be of an acceptable academic standard.

In enhancing international co-operation the following problems must be overcome :

i) The reluctance of some nations to allocate funds to co-operative international environmental research ventures and environmental monitoring. Hitherto this has stood in the way of desirable problem solving effort.

ii) Frequent lack of consciousness of educators and students as to the international dimensions of environmental problems.

iii) Institutions, both academic and governmental, have sometimes been relatively unaccommodating towards the absence and return of students and staff performing international research, teaching or studies.

Part One

AN OVERVIEW AND SUMMING-UP THE RUNGSTED CONFERENCE

by

George R. Francis

Chairman of the Department of Man-Environment Studies
University of Waterloo, Ontario, Canada

INTRODUCTION

THE CALL FOR "ENVIRONMENTAL EDUCATION"

The wave of environmental concerns which swept over the industrialized countries of the West in the late 1960s is still too recent to be placed in a proper historical perspective. It reflected the emergence and coming together of a number of sharpened insights and awarenesses which were brought about, it would seem, by the sense of deterioration of familiar landscapes and settlements, and a rather sudden realization of the magnitude and interconnectedness of the major problems facing the world.

Certainly the component forces at work - the steady growth of human populations ; the drive to maintain economic growth and development in industrialized countries and to launch it over the rest of the world ; the spreading urbanization and rapid growth of metropolitan centres ; and the sustained development and application of science and technology - have all been the object of close attention in various ways for some time. It was with the realization that the dynamic interrelationships within and among these forces were generating all manner of unforeseen and unintended consequences that "environment" came to the forefront. The world seemed adrift amid complexities that desperately needed understanding, not just to avoid the inconvenient and the undesirable, but to preserve the very possibility of continued human survival in a habitable world. It was with this profound sense of an unknown, yet threatening future that the "environmental movement" came forth to rally and respond.

The vigorous public discussion which followed did often show more passion than understanding. The debates and disagreements over what were causes, symptoms and effects, and the demand for immediate action to reverse undesirable trends served to demonstrate just how little was actually known. Out of this came also the realization that problems called "environmental" were manifest in some form everywhere and had to be approached in a concerted manner from a number of different directions at a number of different levels. Above all it was soon recognized that to do this effectively, much greater understanding about the interrelationships of people within their environments would have to be obtained, a view dramatized by the imagery of "spaceship earth" and reflected in the insistent call for greater ecological consciousness.

It is now generally accepted that environmental problems are sufficiently complex to defy once-and-for-all solutions. This has made the need for significant institutional changes all the more apparent in order to cope with them on a long-term and continuing basis. While the public debate reported and stimulated by the mass media is dying down ("pollution" can be front page news for only so long), the seeds of the changes demanded are gradually taking root. A number of OECD countries have, for example, established Ministries of Environment in some form or other to mobilize governmental responses, and a number have made significant innovations in policy, legislation, and environmental management programmes. The international organizations have also responded, notably OECD with the creation of its high level Environment Committee in 1970, and the United Nations with the creation of the United Nations Environment Programme following the major world "Conference on the Human Environment" held at Stockholm in 1972.

The educational implications of the new environmental awareness were also soon recognized to be profound. At issue was not just the need for scientific facts and data, although these were sorely missing in critical areas, but the need to re-introduce more holistic interpretive systems to assess and integrate them. "Environment" in this sense served to proclaim the need for a renewed sense of perspective, balance and integration in the search for a clearer understanding of the human predicament in contemporary history. In other ways it has come to symbolize a need for some countervailing influence against the fragmentation of knowledge and skills into many isolated specialisms even to the point that narrow mastery of the detailed and specific has far too often been accepted as the only goal worthy of pursuit in higher education.

THE CHALLENGE TO POST-SECONDARY EDUCATION

While post-secondary institutions are of particular interest here, there is little doubt that a strong case can be made to promote awareness and some elementary understanding of environmental situations in the primary and secondary schools. If it is gone about correctly "environment" can provide a powerful motivation for learning in the context of general education based on experiences directly accessible to children and youth. Fortunately there are promising signs that this is appreciated in a number of countries.

Post-secondary institutions and particularly the universities pose a greater dilemma. On the one hand in many countries it is they who exercise almost all prerogatives for training the professionals who are most responsible for creating or managing the environments we have, and for generating through research the knowledge and understanding needed to do this creatively. On the other hand, universities, in the Western industrialized countries at least, have a long and cherished tradition of detaching themselves from the immediate concerns of the world and marked resistance to any hint of outside pressures to change their ways. Therefore, while teachers and students from post-secondary institutions in a number of countries often engaged themselves in the debate over "environment" and readily called for change everywhere else in society it soon became clear that the "challenge of environment" was one also posed very directly to the higher educational system itself. Some were quick to point this out. The conventional structure of post-secondary institutions with their monodisciplinary and quasi-independent components and isolated professional Faculties seemed ill-equipped even to accept "environment" as something worthy of serious attention let alone respond to it.

During the later 1960s however, universities in the West were already being challenged through direct confrontations by their own students - Berkeley and Nanterre symbolized the era - and the angry, alienated mood of that period which demanded universities to account for their practices and behaviours, justify alleged complicity in the ills of Western society, and give up hierarchical preserves of privileged aloofness was quick to spread. This movement is also too recent to see in perspective, and it is noteworthy that it already seems to have vanished as fast as it appeared What this may signify is anything but clear. However, in passing, it is interesting to speculate on the possible significance of having had the student mood of alienation and confrontation coincide with the "environmental crises" awareness which swept through the Western industrialized countries at about the same time. Did the perceived environmental crisis help fuel the storm of protest ? Or did a wider awareness of the complexity of societal problems, revealed to some through protesting their existence, generate renewed support for serious intellectual enquiry and research and renewed respect for the importance of enhanced competencies in the professions and related technical fields ?

Either way, the mood and events of the later 1960s made post-secondary educational systems reasonably receptive to some of the innovative changes being proposed under the rubric of environmental studies or environmental sciences. It was largely during this period that post-secondary level environmental education took hold and took shape and it is at least debatable whether the same rate of successful introduction of environmental education programmes could be anticipated if they were only being proposed now. Certainly, it is quite reasonable to expect that countries already having such programmes will create few if any additional ones in the near future. This is as it should be. Any remaining or newly found potential for change and innovation in higher educational systems might best be used in other ways.(1)

FROM NICE TO RUNGSTED VIA TOURS

Discussions of environmental matters make recurring reference to the need for understanding dynamic interrelationships, to overlooked consequences of development and change, to ecosystems and the desirability of seeking a renewed sense of "balance". This not only implies new directions for analytical enquiry, it raises with a sense of urgency the need for syntheses and integration. While academic scholarship and research have always been concerned with integration, the search has been more for unifying theories within established disciplines.

The concerns of "environment" like other more practical areas of human affairs require integration of understanding among disciplines. However, environmental situations pose this need for integrative understanding in almost intractable ways because of the scope involved : "environment" spreads horizontally across the conventional academic divisions of knowledge into the natural (exact) sciences, the life sciences, the social sciences and humanities. Depending on the context, unique combinations of disciplines and their applications through various professions may have to be drawn together from among these.

Therefore, while appreciating the vital importance of continuing scholarship and research within disciplines, the study of environmental questions raises all the issues about the kinds of relationships among disciplines, and it poses all the questions about what kinds of integrations and syntheses are being sought. Should it seek a new unity of knowledge which expresses an authentic interdisciplinarity, or a unity of social purpose and action which cannot be sustained by any one existing profession or discipline, or particular expressions of individual and personal syntheses which weld epistemological and ethical positions into forms of commitment deemed more appropriate for the time ?

These questions reach to the very root of the roles and responsibilities assumed by academic institutions for research, scholarship, teaching, and the general well-being of the society which supports them. Thus to raise them in such a comprehensive way is to query the prevailing rationale for post-secondary educational systems, and, more

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1) "The goal is to work for systems of higher education in each of our countries in which problem-oriented education is the normal pattern in the majority of universities". W. Weidner. "Environmental Education : An Academic Plan for Universities". Keynote Address for the Rungsted Conference, p.16 . The experience of conducting environmental education has much to offer for this course of action.

delicately, the internal social and political structure of the institutions themselves. This is a point to bear in mind when proposals for "environmental education" which seem so well-meaning, generate the reaction and opposition that they have been known to do.

The OECD/CERI "Seminar on Interdisciplinarity in Universities" (1970) (1) was well aware of these implications when it examined the nature and function of interdisciplinarity in higher education. It performed a helpful service by clarifying relationships among disciplines and defining multi-pluri -cross-inter- and transdisciplinarity, by revealing the great variety of ways these are perceived and interpreted in universities, and by outlining more orderly organizational approaches to utilizing interdisciplinary concepts for creative and necessary changes in teaching and research. It may also be noted that in discussions and references at that Seminar, environmental examples were frequently used.

There was still the question of how interdisciplinarity could be made to work in practice, and especially how strategies could be formulated to bring it about in universities. This was examined in the context of environmental education at the Tours Workshop in 1971(2) when by that time people in a number of OECD countries had given a substantial amount of thought to this question as well as to the organizational, teaching and research implication of it. Some post-secondary environmental education programmes had actually been introduced in a few countries, and their initial experiences were reported. "Diversity" was one of the main impressions received at Tours, diversity of approach, of organization, of rationale, and of future expectations. Discussions at Tours were still influenced more by theories, plans and proposals, although the experiences reported gave evidence of vitality of interest and response and of the potential which lay ahead. As one main conclusion from the Tours Workshop put it :

> "Since it breaks new ground on every count, environmental education means that knowledge must be reorganized in terms of present problems and needs of the community. This calls for the revision of curricula, teaching methods and university structures,regarding all of which much remains to be discussed and much has yet to be done." (3)

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1) OECD/CERI. Interdisciplinarity : Problems of Teaching and Research in Universities" Paris, 1972.

2) OECD/CERI. Environmental Education at University Level : Trends and Data. Paris 1973.

3) ibid. p. 284

During the intervening three years a great deal more experience became available to draw upon. The Rungsted Conference in 1974 examined a cross-section of 27 ongoing environmental education programmes - selected as basic case studies from nine countries. They were chosen to give a good indication of the range and variety of approaches and experiences and were not necessarily assumed to be the best examples that could be found. In fact, others equally as good are known to exist. The examples included the ongoing programmes which had been reported on at Tours as well. Since the discussions at Rungsted were based on a more systematic review of the experiences reported, this helped give a much more realistic appreciation of problems than was previously possible.

This paper is an attempt to give one overview and a kind of progress report on environmental education at post-secondary levels based on the information provided and discussions at Rungsted. This is a presumptuous task for any one author to take on, and it will inevitably show the inherent difficulties in trying to sketch out a balanced and fully informed appreciation of the current state of post-secondary environmental education, especially given the diversity of paths which it is taking, the different educational systems within which it is developing, and the speed with which it appears to be unfolding.

Chapter 1

ORGANIZING AND PREPARING FOR POST-SECONDARY ENVIRONMENTAL EDUCATION

THE ORIGINS AND ESTABLISHMENT OF PROGRAMMES

Although there was little direct information and discussion at Rungsted on how programmes came about, it would seem that for the most part initiatives arose largely from within the post-secondary institutions themselves. The response was more to some perceived needs of society than clearly defined job markets requiring graduates specially trained in environmental skills. This was noted in connection with the emergence of programmes in the United States :

> "There has been a great deal of public and student pressure to start programs at once - now. As a result, most programs were hurriedly put together with far more attention placed upon structuring and financing than upon the actual curriculum. At the same time too few questions have been asked as to what each student is expected to be able to do with his environmental education. No one has found out what careers are available to students coming out of environmental studies programs, much less plan a curriculum to prepare students for those careers" (1).

It is likely that the North American system of higher education allows for a more free-wheeling approach to establishing new academic programmes than systems elsewhere. Indeed, the North American practice of financing universities and even individual programmes within them on the basis of student enrolments is a strong inducement for North American institutions to respond to new "student markets" on a hurried and competitive basis.

However, the alternative of trying first to define and quantify some kind of environmental labour market poses its own problems. Immediate needs are of necessity met by graduates from traditional professions and disciplines, and the reported availability of jobs may reflect limitations of immediate budgets and the biases from the particular training of individual government and business officials. The observations of the Director of Studies of the Centre Supérieur de l'Aménagement (CESA) of the University of Tours reflect the experience of others as well.

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1) L. Peterson. "Survey and evaluation of environmental education programmes of selected universities of the United States" in : OECD/CERI. Environmental Education at University Level, op. cit. p. 272.

> "We can now see how mistaken the viewpoint was which consisted in counting up the number of existing openings at a particular moment and adjusting university education to that situation. What is in fact happening is that through its very existence the new education which we provide is creating new openings..."(1)

This does not mean that attempts should not be made to assess manpower requirements (2) but it does serve as a reminder that universities are constantly faced with a dilemma. On the one hand they are expected to anticipate future needs and opportunities in society for people having different mixes of knowledge and expertise, yet if they misjudge a situation, the burden of the error falls on students who graduate but cannot find suitable employment. Thus, while it may largely have been people in the academic world itself who doubted the appropriateness of traditional disciplines and professions alone to cope with environmental problems as they were beginning to be perceived and understood, the most common response has been to strive for modifications within existing programmes rather than create totally new ones.

Within academic institutions, the initiative to develop an environmental education programme readily emerges from a number of diverse source - from students, teachers, researchers or administrators, and from within any one or a few of the established disciplines and professions. The actual point of institutional origin can be important however, since this often sets the main characteristics of the programme which results and is reflected in all of its main features. Immediately, one of the most difficult tasks of the originating group, whoever they are, is to reach out from their own disciplinary or professional base to win the close cooperation and involvement of people in other disciplines and professions. This is to make certain that a reasonable degree of multidisciplinarity gets built into the proposed programme. Given the isolationism of the disciplines and professions in post-secondary institutions, success in achieving this may be rare indeed. One generally does not hear about attempts that failed, but testimony to the difficulty may be seen in the major gaps and rather unusual organizational or curricular patterns that appear in some programmes which have been approved and established.

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1) In "Employment Openings for Graduates", CERI/HE/CP/74.13, p.21. See Annex 2.

2) See S.J. Arceivala, "The Employment of Environmental Course Graduates" for a description of an approach developed by WHO for estimating manpower requirements in environmental health. CERI/HE/CP/74.21. See Annex 2.

The main factors which have to be taken into account in developing and approving proposed programmes varies widely from one situation to another. It is here that the basic differences among countries show up in terms of their historical traditions and institutional structures for post-secondary education, notably in connection with the relative degree of autonomy that universities have vis-à-vis Ministries of Education. Other major differences are evident from the different size of countries. The smaller ones have little choice other than to attempt modifications in long and well-established situations, while larger countries may be able to create new post-secondary environmental programmes as a component of a larger and more diversified post-secondary educational system. It is the smaller countries which also have to take into account more limited prospects for employment among students who graduate with environmental qualifications.

The actual strategies and procedures used to introduce environmental education programmes into higher education also vary with the basic approaches of each country, nevertheless there may be useful comparisons and contrasts to consider. One basic difference is whether the strategy tries to view the whole system of higher education, or whether it is done on a more opportunistic institution-by-institution basis. In Sweden for example, the Environmental Studies Programme approved for the University of Lund was organized to meet four distinct levels of environmental teaching (1) and an approach in the form of an outline scheme to meet seven quite different higher education objectives was described on the experience gained from the University of Louvain in Belgium (2).

Conversely, where the higher education system is so complex as to make planning for the over-all system less feasible, such as in the United States, initiatives and strategies are developed by individual institutions largely on their own to meet self-selected objectives. Strategies for establishing programmes then depend largely on local circumstances. Factors such as the presence of an innovative group within an institution, demands by students, attitudes of administrators and faculty, budget problems, the availability of facilities, and the relation of the institution to the community it is in become all-important in determining whether an environmental education programme be established and the form it then takes (3). Generally, it

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1) See L. Emmelin "The Training of Generalists and Specialists" p. 88.

2) P. Laconte. "Enseignement et Recherche en matière de Sciences de l'Environnement" CERI/HE/CP/74.19. See Annex 2.(Available only in French).

3) These are noted by A.L. Pratt in : "North American Institutional Organization for Post-Secondary Environmental Studies". CERI/HE/CP/74.04. See Annex 2.

would seem that countries which have allowed universities to retain greater autonomy are less likely to be able to plan on a system-wide basis, and universities are unlikely to coordinate themselves.

AIMS AND OBJECTIVES OF ENVIRONMENTAL EDUCATION PROGRAMMES

It is clearly recognized that the approach and content of environmental education has to be adapted to meet needs of students at different levels in the formal education system and take into account the broad objectives of their over-all programme of studies. In preparing materials for the Rungsted Conference this was done by identifying different "target groups" and gathering case study materials on programmes which have been developed for each.

There are at least three broad categories of objectives which are apparent from examples of on-going programmes. These are :

1. Broadening the training of people going into already recognized professions which have an important role in the planning, design or management of various environments. This is to assure that the new practitioners have a better understanding of the environmental implications of what they will be doing and also have more understanding of related professions and specialties so they can work effectively on mixed discipline problem-solving teams and task forces ;
2. Training of technical personnel for clearly specified jobs in government or industrial organizations relating to environmental problems, and
3. Providing an alternative to or revitalization of undergraduate education by utilizing environmental themes and a variety of innovations in teaching and learning. This may be seen as providing an essentially "liberal education" tuned more directly to the contemporary world and the future, and one which lays a more appropriate grounding for subsequent specialization in environmentally relevant fields.

Programmes for professional groups are reviewed in this volume by P.J. Newbould (1). School teachers were selected as a special professional "target group" because of their important role for environmental education in the primary and secondary schools : programmes for teacher training are discussed by R. Clark (2). The "target group" broadly defined as "generalists and specialists" groups together programmes for technical training and those offering broadly-based

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1) P.J. Newbould. "Courses for Members of Professions concerned with the Environment", p.124

2) R. Clark, "Courses for Educators", p.100

environmental education as the context from within which various professional or other specialized skills might be developed : these programmes are reviewed by L. Emmelin and J. Hedegaard. (1)

Programmes for two other important "target groups" selected for consideration by the Rungsted Conference were those for the "recurrent education" of older people in the community (2) and programmes for "decision-makers", a term which includes mid-career professionals and elected or other officials who make or advise on governmental policies (3). Generally, these programmes have the same broad objectives as the others but they seem to be much more recent or less firmly established. However, their importance is clearly acknowledged as giving a kind of "remedial education" in environmental matters for those whose decisions are currently influencing or directly affecting the management of environments or the building of new ones.

There may well be a fourth broad objective which is implicit in some environmental education programmes but has not yet been clearly articulated or announced. It is to work towards the gradual creation of a new environmental profession analogous in a general way to medicine, agriculture or engineering. Like such established professional fields, it would bring together a mix of disciplines and special professions, subjects and skills for application as a "mission-oriented" endeavour to cope with recurring complex social problems and needs. Over time it would generate distinctive methodologies and priorities for basic and applied research needed to support its continuing role in modern society, and in the process it may also help generate some new academic disciplines (4).

One may readily view this possibility with scepticism and ambivalence . It is not just a matter of being uncertain about what charactéristics a "new environmental profession" may come to have or what a new supporting discipline may be. Rather, it raises the

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1) L. Emmelin, p.88 and J. Hedegaard "The training of Generalists and Specialists". p.81.

2) J. Bossanyi, "Recurrent Education in Environmental Science and Management. A paper on some general principles, and a case study in Britain". CERI/HE/CP/74.10. See Annex 2.

3) V. Giacomini. "Courses for Decision-Makers", p. 114

4) This possibility has been argued for the general case whenever a search for interdisciplinarity is viewed as a search for the unity of knowledge. "Whenever the unity of knowledge is mentioned... interdisciplinarity is emphemeral or instrumental, appearing in a moment of crisis, and leading to well-defined single models (transdisciplinarity) or to the birth of new disciplines... Therefore, some current experiments are, by definition, doomed to either disappear or stop being interdisciplinary, in the accurate sense of the word" in : Interdisciplinarity, op. cit. p. 73.

question of whether the attempt to achieve viable multi-or-interdisciplinary processes as a "solution" will not be moulded by the very institutions which support them into renewed expressions of the "problem".

GROUPING OF SUBJECT MATTER AND STRUCTURING THE CORE OF REQUIRED STUDIES

Given the wide inherent scope of "environment" and the manner in which it cuts across disciplines and professions, environmental education programmes have to cope with the rather considerable difficulty of defining, bounding and outlining a defensible structure for a curriculum appropriate to its declared aims and objectives. Within this structure it has also to outline a coherent programme of studies.

Few ongoing environmental education programmes strive for a total sense of comprehensiveness, with the exception of the cases where whole institutions have been devoted to it, such as the University of Wisconsin at Green Bay in the United States. Instead there is more likely to be an attempt to organize substantial re-groupings of subject areas, disciplines, and professions along some major environmental theme or set of themes. It would have been of interest to know much more about the factors which influenced decisions to select some of the actual groupings which have been brought together in particular situations. Undoubtedly there have had to be many compromises between some ideal of what should be and what could be successfully negotiated for a particular institution. This may account for what could seem to be unexplained gaps or unusual programme patterns to an outside observer. To what extent for example, might a given programme reflect little more than narrow disciplinary biases and limitations of whatever academic committee set to work on it, rather than a more carefully thought-out educational philosophy or a more systematic review of needs and opportunities carried out in consultation with others ?

The thematic groupings most in evidence fall into four broad categories. Any given programme may select out or give heavier emphasis to particular component elements or sub-themes while combinations of sub-themes crossing these categories may also be found. The main thematic groupings can be categorized as follows :

1. "Environmental design" which draws upon components from fields such as architecture, civil engineering, town and country planning, landscape architecture, industrial design, regional science and urban studies, along with various of the supporting disciplines ;
2. "Environmental conservation and management" which draws on components from fields such as forestry, agricultural land use,

countryside planning, water resource management, minerals and energy development, fish and wildlife management, and parks and outdoor recreation planning, along with various of the supporting disciplines ;

3. "Environmental health sciences" (1) which draws on components from fields such as public health and hygiene, sanitary and chemical engineering, occupational health and safety, and some aspects from bio-medical science such as toxicology, nutrition and drug use, along with various of the supporting disciplines ;

4. "Human and social ecology" which draws on components from fields such as sociology and social planning, community organization and services, law, human rights, criminal justice, social work, psychology and counselling, along with various other supporting disciplines.

However, there are also important differences in orientation in some programmes which may cut across these main thematic groupings or be oriented to distinctively different target groups within them. The most frequent orientation at the present time is towards applied science with particular stress placed on the acquisition of technical management skills. This coincides well with the approach to professional training in many areas. A few programmes however, are also developing a distinctive public policy and administrative management orientation for environmental themes.

Of particular interest also are programmes for "environmental sciences" which do not just group together existing disciplines from the natural sciences but strive instead to integrate teaching of these sciences by organizing their study around different systems uch as the atmosphere, biosphere, hydrosphere and lithosphere, with particular stress placed on natural cycles and other interrelations among them. Research is devoted to priorities determined by the need for improved understanding of these biophysical systems as systems.

Within these different thematic groupings and major orientations, programmes draw upon subjects otherwise treated within individual disciplines and professions. The case studies and discussions at Rungsted made frequent reference to these, and indicated the relative

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1) At Rungsted, an official from the World Health Organization indicated that "environmental health" has to be seen in the widest of perspectives. "In environmental protection, WHO is most interested in the aspects concerned with the protection of man. We call this environmental health, a term with a broad connotation, ranging from physical planning to bio-medical engineering and including water supplies, sewerage, solid and liquid waste disposal, noise and radiation control, food safety, industrial hygiene, housing hygiene, vector control, air pollution control, to name the major fields". J. Kumpf : "Some Reflections on Environmental Education for Professionals" CERI/HE/CP/74.23, p.4. See Annex 2.

importance attached to subjects by the amount of time students were asked to devote to them. Usually this was done by referring to the number of course units, credits, or hours stated by the curriculum. Unfortunately this gives no clear indication of the context within which subjects were studied nor how the handling of material from constituent disciplinary topics was modified or adapted to environmental themes. This would have been particularly helpful to get at the question of how the integrative or "interdisciplinarity" feature of particular programmes is being developed especially to overcome the difficult problem of handling technology, science and humanities in the context of one single programme.

A further complication comes from the fact that programmes which also provide for elective choice of courses by students - and almost all do,with the range of choice being particularly wide in some North American examples - mean there is no definite way to distinguish between what students could study from what they actually do study. While this has undoubted advantages for education seen as a process of personal growth and development, it can pose problems in obtaining employment upon graduation.

Given the wide range of objectives,"target groups" and grouping of subject matter into main themes and sub-themes, it is not surprising that there is no consensus about what should constitute the "essential content" of all environmental education. This was recognized readily at Rungsted, as was the danger of striving for orthodoxy on such questions. There was a broad measure of agreement that programmes should have at least an introductory course which reflects the broad scope of environmental education, and agreement too on some of the topics which should be covered by it (1). Otherwise the emphasis and form would clearly have to be related to levels, target groups and objectives. In the case of professional education, the difficulties in making any significant changes in curricula were noted (2).

Perhaps one important aspect to this question is the relative emphasis placed on "content" versus "process" in the rationale for a curriculum of studies. If greater importance is placed on the learning process which is thought important for students to experience

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1) In regard to programmes for "generalists and specialists" it was noted that "... a general agreement exists as to which broad subjects should and must be taught (both in general courses and in the more specialized ones), but one gets no idea of the depth of knowledge the student should acquire at the two different levels". J. Hedegaard, p. 85

2) "Professional education, overseen by the busy top men in the profession concerned,is very slow to change. The problem is that the curriculum is usually over-full and it is difficult to throw out enough of the existing content to make room for new material." P.J. Newbould, p.127.

then the content or subject matter is looked upon more as a vehicle or a means to this end, and what is selected to serve this may vary widely. It also reflects an essentially behavioural definition of the essence of interdisciplinarity (1).

Nevertheless, each programme does have a core of required studies which it deems appropriate. Some indication of the actual and possible variations in curricular patterns were reported at Tours and analyzed in the Workshop report (2). The Rungsted Conference did not seem to get significantly further into the logic and rationale for curricula - always an involved discussion among academics - and especially the linkages between the core of required studies and stated objectives of different programmes for different target groups. There was general agreement that what is being sought is the development of expertise within a broad context of environmental awareness and understanding. Certainly the simple dichotomy between "generalist and specialist" was rejected as a statement of the real issue, and discussions were aimed more at how the balance can best be achieved with different types of environmental education programmes. Those which have a kind of "liberal arts" flavour may not have resolved the question of expertise, while those which intend to broaden ongoing professional training often may only manage to do this in a marginal rather than fundamental way.

The whole question of "interdisciplinarity" still remains quite open. The working definitions developed at the Nice Seminar (3) are not in general use for environmental education and the terms for the most part are used interchangeably and essentially synonymously. Most of the programmes reported on at Rungsted could best be described as pluridisciplinary or multidisciplinary but there is nevertheless an active search for how best to establish interdisciplinarity at the core of the curriculum. This search is often expressed in the question of how best to achieve the synthesizing and integrating aspect within a programme of studies. Approaches to this include steps to adapt and apply existing theories such as systems theory (4), subjects such as

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1) "... interdisciplinarity cannot be learnt or taught, for it is a a way of life. It is basically a mental outlook which combines curiosity with openmindedness and a spirit of adventure and discovery..." in Interdisciplinarity, op. cit. p. 285.

2) Environmental Education at University Level, op. cit.

3) See E. Jantsch. "Towards Interdisciplinarity and Transdisciplinarity in Education and Innovation" in Interdisciplinarity, op. cit. pp. 97-121

4) "Any study of a problem arising from man's use of the environment, therefore, technically boils down to a systems dynamic analysis". J.M.Abillon. "Problems posed by Certain Aspects of Environmental Education" in Environmental Education at University Level, op. cit. p. 274.

ecology (1) concepts such as energy (2) or techniques such as computer simulations. Generally, it seems that most programmes are striving for integration and syntheses more by the manner in which they try to orient the learning of students during their undergraduate years or by the approach taken to practical training of professionals for problem-solving skills within a broader context of environmental understanding.

This suggests that the implicit working definition of the "interdisciplinarity" being sought is that of the Unity of the Person or the Unity of Practice rather than the Unity of Knowledge (3). It is generally accepted that a deliberate attempt to integrate bodies of knowledge and theory is a formidable task which takes much time in any event and presupposes much more knowledge of environmental situations than can convincingly be claimed at this time. By and large then, it is the behavioural description of interdisciplinarity best described by A. Briggs and G. Michaud (4) which characterizes what is apparently being sought through environmental education in the post-secondary contest. Thus, it is by examining the approaches used for teaching and learning that insights are more likely to be found, rather than in the formal structure of curricula.

ORGANIZATIONAL ARRANGEMENTS FOR CONDUCTING ENVIRONMENTAL EDUCATION PROGRAMMES

Given the diversity of programmes already noted it is no surprise to find great variety in the organizational arrangements set up within academic institutions to present these programmes. The experience

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1) Ecology has frequently been promoted as the most appropriate framework within which to fit environmental education. For a basic set of propositions which outline this approach, see V. Labeyrie, "Principles Fundamental to the Institution of Environmental Research and Proposals for its Organisation", p. 135, "However... the assumption that ecology is always the most useful basis for environmental studies needs examining more closely in relation to the aims of the programme and the level of teaching". See "The Training of Generalists and Specialists" by L. Emmelin, p.94.

2) See P.J. Newbould "The Teaching of Environmental Studies at University Level" in *Environmental Education at University Level* pp. 107-120.

3) For these distinctions, drawn from a questionnaire survey of ongoing university programmes, see : *Interdisciplinarity*, *op. cit.* p. 73.

4) "Interdisciplinarity is first and foremost a state of mind requiring each person to have an attitude that combines humility with openmindedness and curiosity, a willingness to engage in dialogue and, hence, the capacity for assimilation and synthesis". In *Interdisciplinarity*, *op. cit.* p. 192.

in the United States gives a particularly rich array of examples of these arrangements, including (in general order of organizational scale and/or autonomy) Programmes, Centres, Institutes, Departments, Schools, Divisions, Faculties, Colleges, and in the case of the University of Wisconsin at Green Bay, a whole new university (1). For those countries which have strong centralized Ministries of Education organizational arrangements involving ministerial participation in programmes given by universities may also be present, although the nature of these relations were not discussed at length at Rungsted.

Two quite broad patterns of organization are evident. One provides minimal staff to coordinate an environmental education programme dependent entirely (or largely) on the participation of established Departments, Schools or Faculties within an academic institution, while the other provides a core of professional and other staff to present a programme, and the home institution allocates to them the necessary resources to do it. In other words, they themselves may constitute Departments, Schools, Faculties, and so on.

At Rungsted it was readily agreed that there is no one inherently ideal organizational form.

> "It is clear that there is no model organization for managing environmental studies programmes. Depending upon the requirements of the institution, the needs of the students and the focus of the programme - whether the programme is to be primarily teaching or research or both ; whether the programme is to be separately budgeted ; whether the programme is to be problem oriented - are elements which must be considered before decisions are possible as to the best organization for managing an environmental studies programme. (2)

However, there was also a general consensus that environmental education programmes had to have an organizational unit or base of their own with at least some of the staff, funds and facilities allocated to it and under the control of a designated programme administrator. While it was acknowledged that one danger in such arrangements is that a programme may become isolated within itself over a period of time, even to the point of taking on some of the institutional features that environmental education hopes to overcome, the built-in weaknesses of trying to maintain a coherent programme totally dependent on the voluntary cooperation of others was even more apparent,

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1) See the analysis by A. Pratt "North American Institutional Organization for Post-Secondary Environmental Studies". CERI/HE/CP/74.04. See Annex 2.

2) ibid p.5.

even if this nominally kept environmental education "outward looking" to the larger institution in which it is housed.

The question of who is recruited to teach in environmental education programmes and the criteria used to select them was raised but not gone into thoroughly at Rungsted. It is a question of interest, because those involved in the first round of new programmes established of necessity came with educational qualifications other than "environmental" ones as these are now becoming understood. A number of universities may still be following conventional recruiting criteria which results in a search for accomplished specialists who collectively "cover" the scope of a particular programme without concern for their willingness and ability to work in mixed discipline teams or their openness to trying innovations in educational methods. To the extent this is so, they are in danger of posing demands for integration capabilities on students that the professors themselves have not accomplished (1).

More basic questions have also to be understood better because effective environmental teaching has to call upon a wide range of content, practice, theory, and style. These are discussed by R. Clark in terms of differing epistemological-value positions which programmes having the scope of environmental education bing forth, and which may well lie at the root of difficulties experienced withim mixed discipline teams.

> "For example, by disposition or by experience a person may have become wedded to and practised in the rational-empirical epistemology of the sciences and have developed a personal value construct dominated by theoretical-cognitive concerns - or may have become practiced in, say, the intuitionist epistemological processes and informed by concern for aesthetic values. ... We rarely consider such characteristics of individual members of faculty when trying to assemble teams to do particular jobs".(2)

At least until this aspect to "interdisciplinarity" is better understood, the importance of attitudes as described by A. Briggs and G. Michaud (3) could prudently be recognized along with the particular expertise needed when recruiting teachers for environmental education.

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1) However, reference to the use of other criteria in faculty selection and evaluation were made in a few case studies, i.e. University of Wisconsin, Green Bay, and the University of California, Irvine. See Environmental Education at Post-Secondary Level, The training of generalists and specialists. OECD/CERI, 1974. See also Pratt CERI/HE/CP/74.04, pp. 31-32. See Annex 2

2) R. Clark, p..108.

3) Interdisciplinarity op. cit. p 192.

Chapter 2

CONDUCTING ENVIRONMENTAL EDUCATION IN POST-SECONDARY INSTITUTIONS

APPROACHES TO TEACHING AND LEARNING

Discussions at Rungsted about the approaches to teaching and learning appropriate for environmental education readily reached agreement on the need to consider a balanced set of methods. The importance of utilizing environments other than classrooms and laboratories was stressed ; at the very minimum field trips to observe environmental situations first-hand should be arranged, but more sustained field investigations of environmental problems are better.

Team-teaching and shared-teaching was widely endorsed as a device to introduce students to a wider range of perspectives on problems and issues since it is through discussion with and among teachers that differing insights into the nature of environmental interrelationships can be gained and compared. However, in order for this to be done effectively, teachers have to take time to prepare and coordinate their presentations and also be present with one another during seminars. This is expensive of faculty time and may become ruled out by tight programme administration based on narrow and short-range assumptions about "performance" and "efficiency" within universities. This is especially so where programmes are controlled internally by administrators who rely on quantitative indicators (and pseudo-indicators) to allocate funds and teaching responsibilities, a common practice in North America for example.

Team-teaching situations are the ones which call directly upon faculty having different disciplinary backgrounds, and provide the occasion to demonstrate interdisciplinarity as a process of enquiry. It is here that arguments arising from fundamental and different epistemological-value positions need to be exposed and compared at deep philosophical levels. This itself would be of educational value. Otherwise there is a danger that conflicts and misunderstandings may develop among faculty and revolve around superficial and trivial matters to the point of being disruptive rather than educative. Over time it may lead to their adopting reflex postures rather than carefully thought-out positions, so that the whole potential for team-teaching to demonstrate processes leading towards deeper understanding and intellectual integration is lost.

It is rather unfortunate that the Rungsted Conference was not able to delve more thoroughly into the experiences of different environmental education programmes in this regard. One account of how the problems of getting a mixed discipline team to develop the necessary communication and empathy for one another's disciplines was provided after the Conference and is worth quoting in full.

> "However, before any of these informal techniques (team teaching and team research) could be employed or prove effective, it was necessary to undertake a slightly more formal approach to the subject. From the very earliest years of the development of IES (the Institute for Environmental Studies) two summer programmes were set aside to develop a "think tank" which was known as the Environmental Study Group. These groups were carefully selected teams of 10 to 12 staff members from a broad variety of disciplines, each one known to be particularly competent and enthusiastic in his own field. These staff were brought together in the summer time in a somewhat more informal setting where they presented papers to one another on the subject of environmental sciences. Initially each one tried to indicate where he felt his discipline could contribute to the solution of an environmental problem. The result of these meetings was extremely interesting in that the degree of overlap between the environmental territory claimed by each discipline became quite apparent. Each discipline saw itself as central to the environmental problem and its solution and could only initially see the other disciplines as being somewhat peripheral and perhaps superfluous to the whole scheme of things. After a series of interpersonal battles the "think tank" was sent for a week-end to an appropriate retreat where the members got to know one another as individuals. At the end of this experience those involved had developed the understanding and respect for one another to operate as a team in examining environmental problems. They had learned to respect one another's contributions to team solutions of complex problems and they proved to be the first nucleus of a truly interdisciplinary group which has now grown to more than 100 academics. The second year this process was repeated using one or two of the first year's staff and further 10 neophytes. After the two years were completed the nucleus of 20 or so converts allowed for the implementation of recommendations (concerning the need for interdisciplinary teaching and research and the prior need for a "shared language" to provide a common framework for discussion). (1)

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1) P. Jones "Some Experiences Related to the Recommendations of the Rungsted Conference, June 1974". Institute for Environmental Studies, University of Toronto, pp. 11-12. CERI/CR/75.01 (See Annex 2).

Environmental education is problem-oriented education. (1) This is widely accepted, both as a way of organizing materials for study and to encourage the development of skills to be directed towards resolving environmental problems. Project-oriented learning is a device consistent with this approach, and seems to be in quite wide use within environmental education programmes. It is particularly appropriate for teaching students from different professions how better to work together, and it actively involves students in discovery learning which is generally deemed more effective than if they spend most of their time as passive recipients of lectures.

A number of other approaches and devices were mentioned at Rungsted as worth trying, although it was not clear what the experience has been with these in environmental education programmes. Included here are role playing and simulation of decision-making dilemmas ; computer-aided instruction ; the preparation of teaching/learning materials into self-contained modular units which allow students to pace themselves through basic information and concepts at their own speed and inclination ; and teaching students the use of audio-visual and display methods for handling and presenting the results of their investigations. It became quite clear during discussions at Rungsted that it would be most helpful to have carefully documented examples of the actual use and results experienced from trying to apply particular approaches and devices within different kinds of environmental education programmes. Implicit in this is a need to get more systematic approaches for assessing teaching/learning effectiveness.

ROLE AND ACTIVITIES OF STUDENTS

The attention lavished only a few years ago on student involvement and participation in decisions about post-secondary programmes has seemingly lost its urgency. It was conspicuous by its absence at Rungsted. To some extent this may reflect improved access to students for participation on academic committees, but it may also reflect a significant shift of attitude and orientation, a shift which has been "sensed" in a number of quarters.

This is a shift away from viewing "environment" as the basis for a social movement to challenge established ways of doing things, towards viewing "environment" as providing promising new career opportunities in established institutions. This coincides with various

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1) For development of this theme see E.W. Weidner, p.18. Keynote Address.

adaptations made by institutions, as reflected by new environmental agencies in governments, publicly expressed commitments to improved environmental quality by private corporations, and the emergence of degree-granting environmental education programmes in post-secondary institutions. Students attracted to the latter may now have less interest in involvement with concerns because of their inherent social worth and more on the acquisition of techniques and management skills needed for self-advancement in careers.

Relatively little attention was given at Rungsted to whether and how environmental education programmes provide students with opportunities to acquire work-oriented practical experience as an integral part of their over-all programme of study. It was reported that some programmes provide for on-the-job work experience either as an option in the context of project oriented learning or,at least in one case, as a requirement integrated into the curriculum (1). This requires administrative provisions for a field placement and follow-up service which maintains contact with a wide range of organizations. It would be helpful to know more about how this approach can be made to work effectively, particularly for the diversity of backgrounds which students may obtain in environmental education.

Other experience from North America suggests that students themselves alternate work and other non-university experience with periods of study, depending on opportunities which arise for them. In a modest and personal way they are moving more towards a "recurrent education" pattern than many of the academic institutions they attend. Circumstantial evidence also suggests that students who have spent time out of school before entering university may be better prepared to make effective use of the more open-ended, self-directed learning opportunities provided by some environmental education programmes (2).

There is a clear need to know more about the relative effectiveness of different patterns and sequences of work-study in anticipation of a gradual evolution of higher education towards providing for recurrent life-long education. If planned in a systematic way this may mean that students will not be expected to spend so many years at post-secondary institutions initially, as they do now. This will carry significant implications for the design or re-design of environmental education programmes. One key question is the sequence

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1) See A. Binder "Programme in Social Ecology", University of California, Irvine in Environmental Education at Post-Secondary Level. (1) : The Training of Generalists and Specialists, OECD/CERI,p.171.

2) Informal discussion at Rungsted seemed to confirm this for a number of instances and at least one environmental education programme (at Griffith University, Brisbane, Australia) was reported to be considering requiring deferred admission for students into an undergraduate programme.

of studies which may best encourage students to evolve a philosophical perspective appropriate to environmental education while they also develop and maintain specific skills for work in an environmentally relevant area (1).

The great diversity of programmes that are developing means that students will not all be receiving "standard qualifications" for environmental skills certified by academic institutions and recognized and accepted by various employers. While project-oriented and off-campus work experiences may nevertheless make them better prepared for employment than students from traditional programmes who never leave the classrooms or the laboratories, it would still be of interest to know the extent to which this is so and whether students themselves have seized on this initiative to develop links with potential employers. In how many places, for example, do students maintain documentary evidence of their own project and work experiences to present along with academic records, and what responses have potential employers shown to this ?

ENVIRONMENTAL RESEARCH AND ENVIRONMENTAL EDUCATION

The focus of the Rungsted Conference was much more on educational aspects than on research in support of new understanding about environmental matters. It was implicitly expected that research would be carried on by faculty, and some of the case studies indicated particular areas of interest. Suggestions about the approaches needed for environmental research were given by J.M. Abillon and V. Labeyrie(2) both of whom appropriately adopted ecosystem perspectives in the widest sense not only to guide research priorities but to serve as the basis of a critique of the nature and form of developmental changes which are generating environmental problems in so many areas of the world.

Consideration of environmental research raises a series of questions similar to educational ones, namely, how to get effective research from mixed discipline teams, the need for existing disciplines to devote more attention to problems of environmental significance, the need for adopting a systems approach to orient research priorities, and the desirability of giving quasi-independent status to environmental research institutes in universities. It was informally

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1) For a discussion of these questions, see J. Bossanyi, CERI/HE/CP/74.10. (See Annex 2).

2) See J.M. Abillon "The Special Character of Environmental Research and Proposals for its Organization"p.144,and V. Labeyrie,p.135.

suggested in discussions at Rungsted that co-operation on a research project provides a more effective means of achieving an interdisciplinary interaction and result than does teaching. Extensive experience with this is made difficult however, by the inappropriateness of governmental research policies and funding procedures which in a number of countries still give strong or near exclusive preference to supporting individual research in long established traditional monodisciplinary fields.

The question of integrating research with teaching programmes was also considered, mainly in terms of drawing distinctions in the approach most appropriate to different levels of education. For example, it was suggested that at the undergraduate (first cycle) level the purpose is to introduce students to research methods, using practical environmental problems as examples. Then as students move through the upper years they would progressively be involved in more substantial research, and also be expected to learn research methodologies. Team research on significant local problems by a team of students and teachers can provide good experience and useful results. However, long-term basic research on environmental questions can only be done (or is best done) by professional research personnel working together in multi-disciplinary research institutes.

In a similar way to the Tours and Rungsted Conferences,which were trying to get a balanced overview of environmental education, it would be useful to get some overview of environmental research. As research questions are made more precise they could be expected to be addressed best by an appropriate traditional discipline so that one main role of environmental research might be to ask traditional disciplines the right questions and then devote effort to interpreting and synthesizing answers. Methodologies such as systems modelling might give the basis to pose questions and integrate results.

Rungsted did not deal to any extent with the community service function of post-secondary environmental education programmes. This was touched on implicitly by references to project oriented learning which drew upon situations of immediate importance to communities (1), and to statements about the importance of programmes demonstrating a sense of social responsibility (2). The actual research priorities of faculty engaged in environmental education were not subject to analysis to determine whether they demonstrated a particular commitment to community concerns. Indeed, the few case studies which made mention

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1) Such as the involvement of personnel at the University of Louvain with the new town planning for Louvain-le-Neuve. See P. Laconte : "Enseignement et Recherche en matière de sciences de l'Environnement",CERI/HE/CP/74.19. (See Annex 2),(Available only in French),

2) See, for example, Weidner, p.16.

of research topics did not indicate this orientation nearly as much as they did the variety of interests that a mixed discipline faculty might be expected to display. An underlying problem here is the pressures that universities exert on their faculty to conduct research in rather conventional monodisciplinary formats. Faculty involved in environmental education programmes may already be vulnerable to negative sanctions because of their choice so that a strong commitment to matters of immediate importance to communities around them may only jeopardize their academic careers further.

ASSESSING PROGRESS AND RESULTS

The information about criteria of success elicited from case studies generally did not transcend the superficial levels at which these are usually dealt with in post-secondary institutions.Programmes are successful if they attract students, students are successful if they get jobs, and professors are successful if they publish in respectable journals. Could this be a reminder that post-secondary institutions still remain too complacent about their educational responsibilities and that even the initiatives represented by environmental education have not yet penetrated into traditional attitudes and behaviour ?

In terms of the educational experiences of students, and even though there is so much interest expressed about the need for interdisciplinarity and synthesis "... it is not easy to find explicit descriptions of the product sought from integration." (1) In part it is a report from enquiry more broadly based than is often the case, but otherwise the integration being sought by the educational processes necessarily remain personal ones for each student, and constitute a blending together of cognitive knowledge, values and commitment which evolves and changes over time. Much is yet to be understood about these processes at post-secondary levels and the strategies which may best facilitate the process. (2).

It should also be noted that not everyone needs to strive for broad integrative capabilities to the extent implied in some discussions of environmental education. Capable analysis within discipline

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1) R. Clark, p 100.

2) "If integration is to be at the heart of broad-spectrum environmental courses who is suitable to become an integrator ? How is a potential integrator detected, nurtured and improved ? Is there some inherent predilection to integrate ; is there some necessary prior experience ?" ibid.p.111.

specialties will always be in demand (1), and not every one can be expected to find the broad multi-faceted approach of environmental education congenial.

There was underlying concern expressed at Rungsted about the kinds and amount of employment that may be available to graduates from environmental education programmes. This was particularly so for programmes grouped under the generalist-specialist category since they are the ones which lack an already accepted professional identity. A survey of some graduates from among the first programmes set up was somewhat inconclusive ; graduates certainly found jobs but it is too early to judge their performance and influence compared to new recruits from more traditional post-secondary programmes (2).

The Conference was agreed on the desirability of closely monitoring employment trends ,and for smaller countries in particular it was deemed absolutely essential. Various factors were identified as of importance for doing this ,such as noting the recognized and expressed needs of government and industry, or having analyses done of actual tasks that needed to be performed in particular organizations. Nevertheless the importance of major changes or innovations in science policy, environmental protection policy, or new legislation was also acknowledged since this may create instant demands for expertise (3).

Assessment of the teaching faculty in environmental education programmes also poses problems. A crucial factor in this may be the locus of control over faculty reward systems within the institutions themselves and the built-in sanctions these have against change and non-conformity with established ways. This works very much against the

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1) "... In fact there is nothing wrong, fundamentally, about disciplinarity..." E.W. Weidner, p 20.

2) See : "Employment Openings for Graduates" CERI/HE/CP/74.13. See Annex 2. There may be initial delays in finding suitable employment in some cases because of institutional inflexibility. The following observation could reflect experience elsewhere as well : "... when the first 20 German graduates of Environmental and Hygienic Engineering left their college in Giessen in July 1973, they were confronted with serious difficulties to find a job at all - and this in an overall situation of full employment and particular needs in environmental engineering caused by new laws of pollution control. This absurd situation clearly has to do with the comparatively rigid and slow-going German system of Planstellen (budgetary planned jobs which usually contain a rather narrow and highly conventional definition of the formal qualifications required). This system is backed by the lobbies of the conventional professions..." P. Schneider and E.v. Weizsäcker, "Environmental Education at a Comprehensive University", p. 3, May 1974.

3) The National Environmental Policy Act passed in the United States in 1969 is a good case in point. It created an instant demand for personnel who could undertake environmental impact studies on all manner of public works financed by the U.S. Federal Government.

time and learning needed from faculty if they are to achieve productive interdisciplinary interaction, in spite of it being the essential core process in these kinds of programmes.

The dilemma is strongest for younger academics.

> "In a normal traditional university the promotion, salary, tenure and career potential of a staff member is controlled by his peers or by the chairman of his discipline department. Thus, if a young university teacher decided to devote too much of his time to interdisciplinary activities he would essentially become professionally invisible in his department and be overlooked at such critical times of the year when his career is being assessed. The result of this is that in interdisciplinary activities a frequent problem is that the only staff that can be logically attracted are those who already have reached the senior stages of an already established university career. Regrettably such staff are often the least flexible and may not enjoy the youth and vigour of their younger colleagues. Unfortunately the young man at the beginning of his academic career is usually endowed with all the vigour, enthusiasm and motivation to be active and innovative. Furthermore, he is endowed with the latest of the scientific tools of his discipline but the scales are tipped heavily against the wisdom of his embarking on an aggressive interdisciplinary career until he has established his niche in his discipline. (1)

Until this situation can be overcome it may be quite unrealistic to expect continued rapid change and innovation in environmental education at post-secondary levels, except under unusual circumstances.

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1) P. Jones, CERI/CR/75.01,p.12. (See Annex 2).

CONCLUDING COMMENTS

During the short period of three years between the Tours and the Rungsted meetings there have been quite a number of initiatives for post-secondary environmental education taken in the OECD member countries. To a considerable extent the programmes established have reflected the key features recommended by the Tours workshop (1) and useful comparative information on representative ones has been brought together, analyzed and discussed at Rungsted. There is no doubt that the Rungsted Conference was of particular value to the participants in ways which the written record of it can never properly convey. It gave an unparalleled opportunity for persons most directly responsible and involved in these post-secondary programmes to exchange their first-hand experiences and gain a much needed perspective on what is unique to the particular institutional circumstances each was in and what is inherent to the nature of this common enterprise.

There are several lines of potentially productive follow-up which could be pursued. One which merits constant and sustained attention is that of "interdisciplinarity" now that it is clear that this in large measure is being interpreted as an interaction process which tries to relate and integrate the experience of people drawn from diverse disciplinary backgrounds working in common cause. This is not to exclude "interdisciplinarity" interpreted as the search for "unity of knowledge" in environmental matters, but it does voice the following caution : "integration can be carried too far. In an effort to present a coherent picture of a problem one is tempted to over-simplify... the holistic approach becomes simplistic."(2) However the creative potential of integrative interaction processes is now clearly recognized,whether applied for the solution of complex environmental problems or to the development of individual human capabilities. This then needs attention. Environmental education programmes more than most are organized and motivated to generate rich experience in this regard, and this experience needs to be recorded, analyzed and shared widely.

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1) Environmental Education at University Level, op. cit., pp.31-32.
2) L.Emmelin, p.95.

Now that the understandable preoccupation with getting environmental education programmes established and accepted in post-secondary institutions can be relaxed somewhat, more attention needs to be given to looking outwards. There is need to examine the articulation of environmental education at different levels within the formal education system so that sufficient account is taken of what may now be learned by most students from environmental courses introduced into secondary schools or what may best be learned as recurrent education after sufficient time has elapsed to provide a wide measure of work and other experience. Although the superficial dichotomy between "generalist" and "specialist" has rightfully been rejected as posing a real issue (1), the problem of developing expertise which is thoroughly embedded in the broad context of understanding human interrelations within environments remains as a challenge. Educational systems must make certain that options are available for people to achieve this in a manner and sequence best suited for their own personal growth and development and career needs.

Much might be also learned from exchanging experience with post-secondary programmes organized around quite different thematic structures but facing many of the same problems of crossing disciplinary and professional boundaries. The OECD/CERI review of the health science programmes is a case in point. Others of comparable scope to environmental education include development studies and the emerging scholarly interests in future studies ("futuristics", "futurology") and global studies. To a considerable extent these are responses to many of the same concerns which gave rise to the "environment movement". Perhaps as these thematic programmes become better established in post-secondary institutions, environmental education programmes might develop the necessary interthematic links with them in order to strengthen the intellectual frameworks needed to interpret environmental issues in the world-wide context.

To help give substance to such a perspective it would be highly desirable if ways could be found to exchange teaching materials and experiences, including perhaps students and teachers themselves among programmes in different countries. An opportunity for comparative study of similar problems in different social and institutional settings should help counter any tendency to parochialism, always a possible danger from giving too great a concentration on local environmental situations or community concerns.

In conclusion then, perhaps it will be possible for a future OECD Conference to focus more directly again on the question of

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1) J. Hedegaard, p 81.

"interdisciplinarity" as an interaction process in the context of a variety of thematic programmes, to examine the vertical articulation of environmental education throughout all levels of formal educational systems, particularly those designed increasingly for lifelong recurrent education, and to see what arrangements could be made to bring an international exchange of experience into the day-to-day learning of students and teachers alike.

Part Two

REVIEWS OF COUNTRIES' EXPERIENCE AND PROBLEMS

The twelve case-studies*used in the reviews presented in Chapters 1 and 2 come from the following institutions :

Diploma in Environmental Studies Programme,
Macquerie University, Australia, by A.G. Mitchell.

Interdisciplinary course on "Ecology of Man and Society"
the Flinders University of South Australia, Australia,
by R.L. Heathcote.

Department of Man-Environment Studies,
University of Waterloo, Canada, by G.R. Francis

Department of Environment, University of Paris VII,
France, by J.M. Abillon.

Centre for Higher Studies in Resource (C.E.S.A.),
University of Tours, France, by J. Verrière.

Programme in Environmental Studies
University and Technical Institute of Lund, Sweden,
by L. Emmelin.

School of Biological and Environmental Studies,
The New University of Ulster, United Kingdom,
by P.J. Newbould.

School of Environmental Sciences, University of East Anglia
United Kingdom, by K.M. Clayton.

Degree Programme in Environmental Technology,
Charles County Community College, United States,
by J.N. Carsey.

A Division of Western Washington State College,
Huxley College of Environmental Studies, United States,
by G.W. Miller.

Programme in Social Ecology, University of California
at Irvine, United States,by A. Binder.

University of Wisconsin-Green Bay,
United States, by E.W. Weidner.

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* Case-studies published in : Environmental Education at Post-Secondary Level(1): The Training of Generalists and Specialists, OECD/CERI 1974.

Chapter 1

THE TRAINING OF GENERALISTS AND SPECIALISTS

by

J.Hedegaard, The Polytechnical University, Copenhagen, Denmark.

This paper is an introductory review. So, while my source material has been a number of case studies prepared for the Rungsted Conference, I have attempted to extract experiences and problems countries appear to have in common in addressing themselves to the question of Environmental Education for Generalists and Specialists rather than present a detailed critique of each case in turn. This I believe is likely to promote the most useful sort of discussion in an international forum.

The basic structures of education in our various countries are unfortunately still too different to permit many direct comparisons between the educational experiences in environmental science that have been reported in the case studies, most of which represent only a few years of teaching, or even less when it comes to the evaluation of the results.

As pointed out elsewhere (1) the terms "Generalist" and "Specialist" are open to different interpretations among teachers involved in environmental education. I therefore believe it would be wise if one avoided using them for the time being and concentrated on the more pragmatic aspects of a differentiated environmental education at post-secondary level. These have, in fact, provided the subject matter for the case studies with which we are concerned, as indeed was proposed at the outset by the conference's Steering Group (2).

The last decade has brought about important, fundamental changes in most of our university structures. Frequently, we are still uneasy as to how to handle the new situation - how best to put forward knowledge and information within the framework of a transformed educational system. This is particularly true when it comes to the new multi-

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1) cf. G. Francis, p. 49.

2) The Conference's Steering Group proposed that the case studies follow the same outline : Who does the teaching ? - Institutional Organization - Course Content - Teaching Methods, Media and Materials - Research Base - Criteria of success - Recurrent Education.

disciplinary science, Environmental Science, which has emerged as a major discipline, attracting an ever-increasing number of our students at all educational levels.

No university, indeed no educational system, can any longer ignore that it is the general environmental consciousness among our fellow citizens that lies behind the massive demand being made at the present time for environmental education at all levels.

It is timely now to look briefly at some of the problems that have been encountered in a few countries where environmental education programmes have been running for some years so that starting points may be provided for the general discussions for which the Conference has been convened.

WHO DOES THE TEACHING ?

Answers to questions of this type depend very much on the structure of the educational system. It is quite clear that for undergraduate (general environmental science) programmes the teaching is mostly undertaken by the permanent faculty staff. This is certainly true for most of the case studies presented here. For the students, it has the obvious advantage that the course is given by individuals only, a fact that not only facilitates close personal contact between student and teacher but often makes it easier for the student to assimilate the course content because of his familiarity with the educational, pedagogical methods of the teacher(s).

It is also clear, however, that certain aspects of environmental science cannot be completely covered in a satisfactory way by a smaller staff. If this is attempted some specific environmental problems may have either to be completely excluded from the programme or mentioned only superficially. This outcome may well give rise to some dissatisfaction among the more motivated students.

Only a few university departments have sufficient, broadly trained steff members to provide teaching capacity, and most of the case studies presented to us reflect the problems - if not the actual difficulties - that most environmental departments encounter in recruiting teaching staff. In many cases the employment of part-time staff members has been adopted as a solution. It is not always quite clear that it has turned out to be a happy one, the danger being that such a loose connection between teacher and department could lead to an equally loose relationship between teacher and students. It seems to be important to get this situation-problem clarified.

When environmental science programmes at a more advanced level are taught (often as a follow-up programme for the undergraduate course) it appears from many case studies that non-faculty experts can team-up with the teaching staff with great success. Specialist knowledge is obviously needed at this level and it is not always possessed by normal staff members nor should it be required of them. From a student viewpoint this integration of non-faculty experts with the teaching staff appears to be very stimulating - not only because of the special knowledge they bring to the course but also because of the untraditional teaching methods they often introduce and the contact it opens up for the student with the non-academic world.

In the above, I have drawn particularly on the case-studies from Paris VII, University of Tours, and Waterloo, Ulster, Flinders and Macquarie Universities.

INSTITUTIONAL ORGANISATION

As already indicated, we have before us studies of experiences from many, and various educational systems. These display not only major differences in the build-up of the overall system as between countries such as France and Italy on one side and the Anglo-Saxon countries on another side, but quite different structures even within some of these national unities. In general terms, it appears from the documentation that in the Anglo-Saxon countries (and here I include the United States) there is an organisational freedom for setting-up environmental studies that does not exist in the other bloc - at least it is not reported from any of the countries there (e.g. France or Italy).

While some of the Anglo-Saxon and U.S. experiments represent true and original innovations in the educational field (University of Wisconsin - Green Bay, for example) most of the European environmental studies began as something added to already existing educational programmes - usually in the fields of biology, botany, zoology or geography.

The creation of total educational structures (universities) more or less completely dedicated to an environmental understanding may only be advisable for larger countries where the graduates from such an environmental university will still be outnumbered in the country as a whole by classically trained, less environmentally specialized graduates. In the smaller countries it will continue to be difficult to know what the employment demand will be for highly specialized environmentalists and, therefore,what provisions the university should make.

A solution that has been widely adopted is the creation of new, relatively independent environmental departments or schools inside an existing university. Several of the case studies imply that such environmental departments have succeeded in placing environmental study programmes as a synthesizing element in relation to many of the traditional disciplines, such as biology, chemistry and hydrology, etc.

Often, however, we see that environmental studies are still linked to an established educational unit -quite often one of the departments for the natural sciences. This is a most unsatisfactory situation since the staff at such a department cannot be environmentally specialized, nor will it be possible for them to invest all their time in environmental studies. An intermediate solution, which could eventually be adopted where independent environmental departments cannot be created, would be the creation of environmentally specialized sub-divisions organisationally related to existing educational structures.

Special attention should be drawn to the very specific and obvious needs for environmental education in the training of engineers - technical, sanitary and veterinary. There are, of course, important differences between the organisational structures of technical colleges and traditional universities - and these are reflected in the educational approach to the build-up of environmental study programmes. The recent creation in many technical colleges of such programmes with a specifically engineering orientation should be seen as an educational innovation of the greatest importance for society.

When an entire university is dedicated to environmental understanding and study, the planning of its programmes stems directly from its primary goal. When, however, an environmental study-programme is an additional feature to already existing disciplines, its planning becomes a function of the academic side of the university, technical school, teachers college or whatever the parent institution may be. Thorough planning of the environmental content is obviously a very important factor in the realisation of these interdisciplinary programmes. What we have already said under "Who does the Teaching ?" is relevant here; so is the following section "Course Content". The principal case studies I have drawn upon for this part of my review are from the Universities of Paris VII, Tours, Ulster, Flinders, Waterloo, Lund, University of California, Huxley College, and the Polytechnical University of Denmark (unpublished).

COURSE CONTENT

From the information given in the case studies it is, frankly, difficult to get a clear impression of the real content of any of the environmental courses, whatever the educational level or university. In most cases, topics such as ecology, biology, chemistry, physics, sociology or economics (that is, matters of overall environmental significance) are shown to be allocated an amount of study time,but as these names alone are used without qualification the courses look the same whether they are designed for undergraduates or for specializing students. Thus, one is left with the information that general agreement exists as to which broad subjects should and must be taught (both in general courses and in the more specialized ones), but one gets no idea of the depth of knowledge the student should acquire at the two different levels. The great differences between our various educational systems are, no doubt, partly responsible for this obscurity when we are talking internationally. Obviously, in many of the instances reported in the case studies, this and/or that course with this or that specific content will lead to either a certain diploma or to the attainment of a certain number of "points". However, when analyzing the significance of this kind of information, we are again faced with the fact that a certain number of "points" obtained for a certain course and as a function of the course content is only meaningful when these "points" are shown in comparison with what are obtained for other courses and what is needed to obtain a diploma. What is more, it still remains very difficult to evaluate the course content at one university against that of another, even though the key-words may be the same.

In this same context of course content there is one factor that deserves special attention. It is quite clear that some environmental courses are directly oriented by and towards a man-environment philosophy, while others have an overall nature-ecology orientation. Which of these two attitudes is to be adopted will obviously depend on the primary educational objectives of the university concerned ; nevertheless the problem as such seems well worth a thorough discussion. Finally, we should take note that the course content at the more specialized educational institutions has, not unnaturally, a specific orientation. We have already cited examples from engineering and medicine.

In this part of my review I have drawn particularly on case studies from the universities of Paris VII, Tours, Ulster, Lund, Waterloo, California (Irvine), Florida State, Huxley College, Indiana, Wisconsin Green Bay, Flinders, and Macquarie.

TEACHING METHODS, MEDIA AND MATERIALS

It emerges quite clearly from most of the case studies that the pedagogical innovation is essential before optimal results can be achieved in the teaching of environmental science. In the first place it is very important that the teacher and the student are aware of the difficulties that the interdisciplinary character of environmental science introduces for both of them. A very interesting aspect of this is the need, often expressed by students for several teachers simultaneously during a single course, or part of it. It should also be noticed that there is general agreement on the importance of a high teacher/student ratio.

As previously emphasized, the participation of non-faculty professionals as teachers, mainly for specializing students, may often result in educational innovation on account of their original teaching methods.

Practical field work is recognized as of the greatest value. Not only should students on the elementary course have the opportunity of actually reproducing environments of ecological significance but also of following up such systems when they are under deterioration. For this, interdisciplinary groups of students should be organised. More specific field work should be undertaken by the advanced student and this should include excursions relevant to the subject in which he is specializing.

Environmental science being a new discipline it seems quite logical that it should require not only novel teaching methods but unconventional educational media and materials as well. In most cases, lectures on traditional lines are already being replaced to some extent by seminars, individual informative discussions between student and teacher, library work for the student together with a teacher and so on. Intensive use of the newer pedagogical techniques, documentary films and television are also generally recommended.

It is characteristic of the situation at the present time that, although there is already an abundant literature, it seems in many cases to have been difficult to find educational material (textbooks, etc.) immediately suitable for environmental courses - either at general or specialized level. In many cases the teaching staff have themselves adapted the educational material used in a specific course, not only to the educational level and background of their own students, but also to illustrate other specific or local environmental problems. The principal case studies used in this part of the review are from the Universities of Paris VII, Tours, Lund, Ulster, Waterloo, California (Irvine), Florida State, Indiana, Wisconsin-Green Bay, Macquarie and Huxley College.

RESEARCH BASE

It has generally been recognized that behind any educational, pedagogical or teaching activity there should necessarily be some on-going research activity. This is obviously true for the fundamental disciplines, but the situation is somewhat different for subjects of an interdisciplinary character, such as environmental science. Disciplinary research on a limited scale obviously can and will be carried out within the confines of an environmental department, but anything approaching a complete project can only be undertaken when several disciplines/departments pool their knowledge and capacities. This requires not only resources (money and manpower) but a very definite commitment from the participants in such a project. One may say, therefore, that research within the province of environmental science requires stronger motivation and a greater maturity than is demanded by the more traditional disciplines.

Student participation in environmental research does not appear to show any significant differences from any other student research. The motivated student will soon enough get an introduction to the meaning of research, and this initiation, as in the other disciplines, may well determine his subsequent choice of career.

Chapter 2

THE TRAINING OF GENERALISTS AND SPECIALISTS

by

L. Emmelin, University and Technical Institute of Lund, Sweden.

THE SPECIALIST GENERALIST/CONTROVERSY

In most discussions of environmental education the controversy over whether to educate specialists or generalists usually crops up. I see no hope of its being resolved but would nevertheless like to make a comment on it.

First it is obvious that the use of the two terms varies depending on outlook. In speaking about a graduate from, for example, CESA at Tours, it would be reasonable to use the term generalist if he was being compared with a traditionally trained ecologist. To the planner or politician, however, the CESA graduate is undoubtedly a specialist on natural resource management.

Secondly, it is obvious from an examination of programmes that there is a distinct core of subjects that are considered central to most programmes even though the actual choice of subjects is variable, e.g. ecology at Ulster or geographical subjects at East Anglia. Thus few programmes actually attempt to create a generalist in the wide sense of the word but someone who is well educated in a range of disciplines. The correct descriptive term for most programmes in accordance with the nomenclature suggested at the OECD/CERI symposium at Nice seems to be "pluridisciplinary" (1).

THE CLASSIFICATION OF PROGRAMMES IN ACCORDANCE WITH STRATEGY OF INTRODUCTION

Most programmes in environmental education at university level seem to belong to one of the following four categories :

1. Integration into all subjects and courses where relevant ;
2. Short courses designed to impart awareness of problems, motivation for in-depth studies, etc. ;

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1) cf. "Interdisciplinarity : Problems of Teaching and Research in Universities", OECD, 1972, pp. 25-26.

3. Training of experts in various disciplines. This can be done with more or less environmental relevance. The terms "expert" and "discipline" need not be all that narrowly defined (i.e. meaning present academic disciplines). Expertise can be taken to mean the ability to handle complex problems using the tools provided by education ;
4. Environmental education for professionals, decision-makers, and the like. Administrators, engineers, lawyers, planners, etc. need training to enable them to handle environmental problems within their own spheres of work. In a sense this is remedial education,since level 1 is not working in most systems.

This rough classification seems more relevant to our task of providing environmental education (a task which contributes to the efforts to solve and/or prevent present and future environmental problems) than the undefined terms "generalist" and "specialist".

WHO DOES THE TEACHING ?

The answer to this question is all too often : "whoever is available". Organizational constraints in the form of departmental structure, methods of finance, etc. rule with a sometimes very heavy hand. There seem to be two major trends in the cases reported. Either the programme consists of a small organising core staff with mainly administrative duties and a teaching staff assembled from both outside and within the university, or a fairly small core staff which also carries the entire teaching load.

Within the university system there seems to be a common experience (as for example in CESA), that at the beginning of a programme emphasis is put on expertise in the choice of teachers. In time, more importance is attached to teaching ability and willingness to integrate with the programme. From the students' point of view a smaller number of teachers is often desirable. This makes for continuity and simplifies many aspects of coordination and tuition. If student/staff ratios are reasonable, less formal and more motivating methods of instruction can be adopted. It becomes possible for staff to sit in on each others' lessons - a very valuable method which is brought out in the Flinders case. These and many other arguments can be raised in favour of small numbers of teachers. There is, however, one very real danger in this approach. Environmental problems are fragmented, knowledge about them must come from various sources and first-hand, practical experience for teachers is vital. This requirement cannot be met by a small group of academics. The university may have sufficient expertise to provide the basic knowledge for an understanding of the problems but a wide variety of practical experience is seldom available within a small group of academic staff. In certain areas even the basic disciplines may be lacking (Macquarie University).

INSTITUTIONAL ORGANISATION

It is apparent from the material that innovative experiments are much easier in the U.S., British and Canadian systems where a great deal of autonomy exists. In the strongly centralised systems, such as those in France or Sweden, local initiative and experimentation is hampered. In theory, these systems have the advantage of a certain degree of quality control that can be imposed on the universities. In some universities one sometimes has a feeling that a number of existing options are thrown together by one or more departments under the label "environmental studies" in a desperate attempt to increase student numbers (cf. A.L. Pratt, North American Institutional Organisation for Post-Secondary Environmental Studies, CERI/HE/CP/74.04).

The organisation of a programme is closely connected with the problems of a research base. In most cases the existing organisation will be the major factor deciding whether a unit with its own research base can be constructed.

In major reorganisations or the founding of new universities a structure that cuts through the system to the top may be feasible. The names of such a vertical organisation may vary - school, faculty, etc. between different systems. The important aspect here is that it is answerable directly to the governing body of the entire university, has its own budget which is allocated directly to it and other such aspects of material independence. It contains several sub-units with the major component disciplines - it is multidisciplinary or at least pluridisciplinary. It must, however, not be self-sufficient to the point of not utilising teachers from outside the university or from other university departments. It combines teaching with research and is thus responsible for students at all existing academic stages. Aspects of this type of organisation are brought out in the case studies of Wisconsin-Green Bay, Waterloo, East Anglia, Huxley, Ulster, California and Tours.

In systems where it is not feasible to establish a "school of environmental studies" with separate facilities it seems important not to place environmental teaching within an existing department (such as biology) or between two departments (usually geography and biology). This is not because the programme would lack dedicated staff and genuine interest from the departments (genuine interest defined as an interest in the environment rather than in getting or retaining students). My objection to placing environmental studies under existing departments is due to a fear that other departments may lose interest or start to equate "environment" with "biology" or "geography". Changes in staff and perhaps pressure to include more of the subject matter, taught by the departments running the programme, than may be relevant, would also seem to be greater if this arrangement is adopted.

If a separate group of some kind is set up to run environmental studies, it is of the greatest importance that resources are directly available to the organisers. Drawing upon the goodwill of departments (Macquarie) is in my opinion not enough in the long run. The integration of subjects makes it necessary to have the means of buying instruction from departments. Only if one is in a position to buy can one avoid the situation in which the course content is in fact determined by the contributing departments rather than by the responsible group. An example of the pressures put upon the organisers of environmental studies to rely on departments and their existing courses is given in the Tours case study.

COURSE CONTENT

The "process-over-content" approach

G. Francis (Waterloo) argues forcefully that "a plausible case can be made for including almost any subject under "environmental studies", so that a content approach to defining a curriculum would really become little more than an exhibition of the disciplinary biases and limitations of whatever academic committee set to work on it. The adoption of a "process-over-content" approach was deemed even more valid when considering the implications of what may be the single most important educational challenge now facing post-secondary institutions - that of being expected to decide today what kind of education and training will best serve the first groups of people to enter the 21st century in their working years".

This attitude is also evident in the US programmes (most clearly in those at Wisconsin-Green Bay and the University of California) and it would seem to stem from the general educational tradition and outlook of the English-speaking world. The behavioural goals of education in general are more stressed through all levels of the system, the difference being greatest in post-secondary institutions e.g. the north European institutions have a much more vocational orientation. In a sense this attitude could well be considered as a modernisation of the "liberal arts approach" to the education of decision-makers, administrators and the like.

Sequence of Specialised and Broad Studies

The attitudes to content described above must be seen in relation to national educational systems. As P.G. Newbould (in Environmental Education at University Level : Trends and Data, OECD, 1973, p. 107) points out, many of the British undergraduate programmes were set up in a situation after the Robbins report when a combination of generalised undergraduate studies were seen in combination with specialised postgraduate education. A combination of such education would make it more natural for undergraduate education to concentrate on behavioural goals and fundamental knowledge since the pressure on the university to provide a direct entrance to the labour market would be smaller.

In systems such as the north European where undergraduate education is fairly specialised it becomes more natural to concentrate on broadening out and providing what might be considered remedial education (analogous to recurrent programmes such as the Southampton extramural courses ; see CERI/HE/CP/74.10). This approach leads programmes to be multidisciplinary, for example, ESP, Lund's 40 point.

Unifying Concepts of Themes

The need for synthesis of knowledge from many disciplines is usually stressed as a primary goal for environmental education in relation both to content and to the behaviour of students and staff. It is usually attempted in curriculum design and in the use of various forms of active learning. In many programmes more interdisciplinarity may in fact be achieved by the choice of teaching method than by the design of course content (cf. remarks on practical work, below). The themes or concepts used for unification vary. Paris VII stresses energy,several programmes use ecology, East Anglia geography. Other programmes use techniques such as systems theory and simulation as unifying concepts. The Wisconsin-Green Bay case study mentions the concept of the "role" as unifying behavioural and social science aspects. In general it looks as though organisational arrangements will decide the extent to which integration using unifying concepts can be carried out. In course unit systems, or other systems where integration between larger units may be difficult to achieve, the role of practical work for promoting integrating appears important. On the other hand, the argument seems quite as valid if it is turned around. Almost any environmentally relevant subject can be used to create the desirable attitudes and basic intellectual skills, provided the right kind of learning situation and facilities obtain. Therefore a programme designed with course content as the primary variable may be just as successful in this respect provided attention is paid to problems of method during the actual teaching of the courses. In the eyes of employers, funding bodies etc. the "content" approach usually has the greater appeal.

In the material for this study there are two groupings with regard to attitude towards content. The first is that described above. Wisconsin, Green Bay, Waterloo, Huxley and the University of California are obviously very broadly oriented towards environmental problems. The course unit system makes it impossible for an outsider to assess the exact subject matter an individual student will have gone through. (This is considered of secondary importance in relation to the goals of the education offered).

In the second group are those programmes which, from the point of departure of a number of disciplines, have identified major deficiencies in the background of persons at present working with environmental problems - be they planners, scientists or professionals. These programmes are typically undergraduate education and pluridisciplinary in nature. The core of their content may be biological as at Ulster or geographical as at East Anglia.

It would appear that Category 4 in my list of programme types (the education of the large group of professionals who, in fact, make many of the most important decisions) is being neglected. Here, we are considering the large group of will-be professionals in other disciplines who will, in fact, eventually be making many of the most important environmental decisions. It is, I think, arguable that this may be a very serious neglect since no amount of well trained graduates from a biology-geography course can replace, say, engineers. A chemical engineer who can "design with nature" - saving energy and raw materials, minimising effluent, etc. - is perhaps more urgently needed than any of the people that present programmes turn out. The remedial teaching offered by Macquarie and Lund programmes may be a partial solution to this particular problem.

Another solution to the problem of technical training is offered by the Charles County Community College where training for a certain specialisation in environment protection is given. This case study conforms with the others in that training is seen in a larger environmental context. The rule for such training of technicians (in Europe at least) is that it concentrates on the immediately useful skills and present technology. Although this prepares the student to fit easily into a particular job it hardly provides the wider knowledge that one would like to see in people working with environmental technology. In general it would seem beneficial if universities concerned themselves more with this type of shorter vocational training.

The Role of Ecology

The assumption that ecology is always the most useful basis for environmental studies needs examining more closely in relation to the aims of the programme under review and the level of teaching. That the ecology of man is a useful intellectual framework for "liberal arts" programmes such as Wisconsin Green Bay and Waterloo seems to me quite clear. On a different level it also seems evident that basic ecology is a necessary component of courses on conservation, wildlife management, forestry, etc. Much less clear to me is the exact use of ecology in the daily work of planners, pollution control officers, and health inspectors. The qualitative rather than quantitative nature of much ecological knowledge, the lack of quite fundamental knowledge in certain ecological fields would seem to put severe limitations on its practical usefulness. In certain types of programmes - particularly those with a significant proportion of students with job experience - this may be a major problem. Whereas those designing a programme may want to spend a reasonable amount of time on ecology to ensure that some basis for an ecological outlook is created, the student may well be frustrated by the time spent on something that is not felt to be of immediate use. It is difficult to get a good discussion on this point since a polarisation of views exists to the detriment of communication. Designing a curriculum which is ecologically sound and still professionally acceptable to planners, engineers, their professional organisations and employers, would seem to be one of our most urgent tasks today. Yet the situation seems to be that the representatives of these professions either reject the intrusion of ecology as being of no practical use or they have joined the movement which sees ecology as the immediate answer to almost any problem. The claims of the latter group must be horrifying to professional ecologists as their teachings are unrecognisable as ecology.

TEACHING METHODS, MEDIA AND MATERIALS

The willingness to explore new, less formal ways of teaching probably goes hand in hand with the willingness to include new subject matter. In many ways "environmental science" ought to be (and probably is) the scene of a great deal of pedagogic experiment. Indeed, it has been claimed that a number of educationalists in secondary education have climbed on the environmental bandwagon as a means of testing new methods of teaching.

It should, however, be noted that good teaching is, to a large extent, a question of money and manpower. It has become fashionable to blame lack of motivation on the part of students, as well as uninspired, mechanical lecturing, lack of intellectual stimulation and exchange, etc. on reactionary and authoritarian attitudes of academic staff. While not denying the need for changed attitudes towards the learning process on the part of many university teachers, I would claim that - at least in environmental studies - the most urgent need is for a reasonable staff/student ratio. Funding bodies tend to call for changes of attitude on the part of staff. This is, of course, much cheaper than providing resources for a situation where other, more labour-intensive and expensive methods of instruction (seminars, laboratory work, project work, field work) are possible.

An excellent example of the fact that teaching methods are a function of available resources is the description in the Wisconsin-Green Bay case study. It might be argued that given the right kind of student/staff interaction an intellectually satisfying learning will take place even with fewer gadgets available and less expense of energy and resources.

The importance of community interaction is stressed in some case studies - notably Waterloo and the University of California. This is yet another aspect of the benefits of practical experience. It would be most interesting to study cases from the third world where teams from universities ought to be able to become usefully involved in a way that may not be possible in the United States or Europe.

There seems to be a definite agreement on the need for methods which create interdisciplinarity of approach. While not disagreeing with this, let me add a caution : integration can be carried too far. In an effort to present a coherent picture of a problem one is tempted to oversimplify - the holistic approach becomes simplistic.

The different approaches to problems taken by the various sciences must be presented clearly. This is sometimes found to be confusing for students and mistaken for overlap between teachers attributed to bad co-ordination. Letting students discover the different approaches by working on their own on problems with material from various sciences avoids irritation and probably brings the point home better than having representatives of the sciences lecture on the problem. The system of writing essays and discussing these in tutorials and seminars would seem particularly useful here. Working with reprints of original scientific articles (as at Ulster) and having recommended readings rather than fixed reading lists for courses are other means of achieving diversity and simulating real life in the learning situation.

The value of practical work is stressed in most of the case studies. Two types of such work would seem to exist and to be complementary. On the one hand there is the kind of practical work that brings a variety of subjects and people to co-operate on one problem ; on the other there is the traditional scientific in-depth pursuit of a problem. The latter may be a particularly useful exercise in undergraduate programmes to illustrate the power of the traditional scientific approach to solve certain classes of problems. The former type of practical work should always aim at reproducing a real situation and the solutions should, if possible, be tested in some other way than just evaluation by staff. Programmes where students of varying backgrounds are brought together are in a particularly favourable position with regard to practical work in that it becomes easier to imitate a real situation. (This may be one of the most important points in favour of environmental studies at the post-graduate level).

On field work there is also consensus. The land management oriented programmes tend to include field work in several different ecosystems in order to give students first-hand knowledge of them (Macquarie), whereas others tend to use field work more as an educational tool.

The assessment of students may be a major hindrance in the development of practical group work since it is usually impossible to define the inputs of the individuals. This is particularly true if the work has been successful in the sense that an inter-disciplinary team effort is achieved. It is sometimes claimed that students will work well only for projects that are assessed and which therefore contribute to their final marks. This is not our experience with the Lund's 10 point programme where many groups (including their tutor) spend far more time than could reasonably be asked of them because they are looking into a real and important problem.

RESEARCH BASE

The need for a research base for teaching is acknowledged in most cases. It is most forcefully put in the East Anglia study - "we must stress the interaction between these activities (teaching and research) which are as closely and as complexly related as man and his environment" and "academic innovation and progress towards true interdisciplinarity are more likely to begin with research than with teaching. Indeed, I would go further and assert that only if it begins in research is interdisciplinarity likely to be soundly based and academically viable".

The last statement may seem rather hard upon those planners who attempt to create a programme out of contributions from existing departments (Lund, Macquarie). In this model, the teachers retain their contacts with the contributing disciplines. (Interdisciplinarity would not develop if only research could breed it). Apart from the fact that organisational constraints usually determine the model one has to work with, the important factor would seem to be whether one favours a multidisciplinary or an interdisciplinary approach.It also seems that a crucial factor is whether one adheres to the "academic" view that specialisation and standards are causally linked". Putting it another way, one may hold the view that to be good, interdisciplinary research should also be good by the discipline standards (the same standards by which the individual research worker is judged and promoted). An organisation of the "school of environmental sciences" type of a size large enough to have more than one representative of the major disciplines would seem to be ideal in the sense that close enough co-operation and contact would be maintained between disciplines for interdisciplinarity to develop while at the same time permitting the individuals to retain some contact with their basic disciplines.

The usefulness of the research base is well described in the Wisconsin-Green Bay case where student projects are integrated with on-going research programmes. The learning experience and motivation created for the student by his participating in such a project is probably most valuable. The close connection between undergraduate teaching and research is likely to benefit not only teaching but also the research worker. Having to instruct and present his programme means reviewing and reappraising it for the scientist.

One particular problem exists with research base in relation to environmental teaching. Much of the argument for a research connection is evidently based upon the assumption that a research involvement is necessary to make teachers well read and follow modern developments in their field. It could be argued that the specialisation necessary in research combined with a significant teaching load would invalidate this assumption.None of the case studies discusses this or what social rewards could be constructed to motivate a teacher with no research involvement to be well and broadly read.

Finally, I would like to draw attention to the value of other research-oriented or research-based activities such as the seminars described in the East Anglia case study and the catalogue of projects in the Lund case.

CRITERIA OF SUCCESS

The fact that students get jobs may prove of little value when not much is known of how the candidates are evaluated. It may indeed prove nothing more than that the bandwagon effect has also created a small number of jobs where the employers have no clear idea of what to look for in the candidates. The labour programmes such as those offered by Macquarie, Tours and Lund. When a larger number of graduates from different programmes are looking for jobs, the employment of people from any one of these may be the result of successful marketing rather than relevance of the education.

As pointed out by R. Clark in his paper (cf. chapter 3) the behavioural goals that most programmes set for their students are hardly ever assessed. Student satisfaction is one useful indicator of the teaching methods and to a certain extent the relevance (or perceived relevance) of the content. The people involved in giving the courses are hardly the ones to discuss student satisfaction except in very general terms. This is clearly reflected in the case studies.

The five case-studies *used in the review presented in Chapter 3 come from the following institutions :

Institute of Behavioural and Environmental Sciences, University of Rennes, France, by G. Richard.

The School and Institute of Education, The University of Liverpool, United Kingdom, by W.E. Marsden.

School of Education, University of Reading, United Kingdom, by T. Davey.

Department of Environmental Science, Northumberland College of Education, United Kingdom, by L. O'Donnell.

School of Natural Resources, University of Michigan, United States, by P.M. Sandman.

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* Case studies published in : "Environmental Education at Post-Secondary Level(2): Courses for Educators, Decision-Makers and Members of Professions concerned with the Environment". OECD/CERI, 1974.

Chapter 3

COURSES FOR EDUCATORS

by

R. Clark, Education Centre,
The New University of Ulster, United Kingdom

COMMENTARY

To participate in the education of students who are preparing for environmental education is to engage in a complex commitment ranging from the personal characteristics of the "teacher of the teachers" to the milieu in which the students may eventually serve.

The case studies here reviewed disclose a number of significant influences and various ways in which these factors have been seen and responded to. Any case study presents partial evidence, for it conveys one perception of its circumstances and procedures. It rarely reveals forms of personal interactions and the flows of ideas and interpretations that form such a crucial part of any teaching situation. There is thus a communicable part of the curriculum context and a part of the curriculum which grows organically and remains personal and private to the participants. Given these constraints the case studies fairly represent the variety of views and practices in teacher education for environmental education.

A consideration of the salient characteristics of the case studies, their commonalities and the differences among them will be followed here by examination of some major issues concerning teacher preparation for environmental education. Our purpose is to identify issues and clarify problems, rather than to specify necessary content and procedures.

The Northumberland College can be taken as representative of the College of Education where most initial teacher education takes place in Britain, and particularly those that have pioneered environment-oriented courses. This College planned and initiated its Environmental Science course in 1963-64, and so the case study is based on long experience and review. Northumberland was probably the first College to concentrate upon conjoining the biophysical sciences through the study of real situations.

Environmental Science is the only science course at the College, and is distinct from the sociology, history, and human geography courses with which its students have minimal contacts. It is biosphere oriented at a biophysical level, working mainly at local and regional scales. It does not claim to extend itself towards the humanities and social sciences, and is not community-oriented. It is, in the main, cognitively structured and it places little emphasis on affective evaluation and attitude formation other than in relation to course work.

Within this framework students gain competence in the earth, life, and physical sciences, and in horticulture and agriculture through the study of particular situations and systems, and by growing plants and keeping animals. In this way the power of explanation and prediction about places is enhanced, the relationships between sciences is clarified empirically, and practical abilities to work in the field and with plants and animals in the classroom are developed. This is supported by the strong pedagogic bias in the complementary college courses.

Performance is judged by attitude to course work, but especially by cognitive growth. This is familiar to school-leavers from a similar academic climate and acceptable to a teaching staff characterised by subject expertise and a willingness to operate in a conjunctive (possibly partly multi-disciplinary, partly interdisciplinary) situation, and attracted both by the opportunities for extended field and practical work and by the degree of personal control they themselves can have over their own contributions to the course.

The Michigan and Rennes courses show interesting and significant variations from the Northumberland pattern, and between themselves. Rennes, like Northumberland, apparently stresses cognitive gains more than attitudinal development, although (because of its institutional context and purpose) its primary concern is not with pedagogic skills and interdisciplinarity is more restricted to the life sciences and their application. An important concern is to sustain and develop the ecological and ethological aspects of the life sciences and to resist the domination of "molecular and cell" orientation.

Like Northumberland, Rennes places a strong emphasis on field study and on dissertations based on personal or group investigations. The local and regional scale of operation is again apparent. The qualities looked for in academic staff also appear similar, given the greater concentration on life sciences at Rennes.

Certain comments from these two studies may be noted here. From Northumberland come the remarks that combined science and environmental courses attract low esteem in academic circles, and that extended coverage (e.g. to include a spread from humanities through sciences) induces superficiality of treatment. From Rennes comes the idea that it is possible to conceive of a nation's needs in environmental education, and that this process might well start at the primary level.

The Michigan programme demonstrates significant differences, in both content and intention. Field experience emphasizes community issues examined through a range extending from ecological to sociopolitical. There is thus practical recognition of the necessity of a broad spectrum for understanding such issues. Secondly, the programme is explicitly concerned with curriculum processes and expertise in environmental education.

The concept of "environmental effectiveness" as a major goal is basic to this programme, as is a necessary balance of affective and cognitive growth. It seems clear that, as the intention of the programme is to help "a person who wants to be so and wants to help others become environmentally effective - through teaching - or some other strategy or combination of strategies", then the appropriate form of course evaluation is substantially clarified. But this does not directly imply that all persons are expected to, or required to, become "environmentally effective". Thus it does not assert an overriding necessity for programmes of its own type in the schools.

In pursuit of this goal students are introduced explicitly to social change and to the study of values and value positions. Unlike the previous cases, in this programme social critique is an intrinsic part of the course : it is interesting to record Professor Sandman's comment that although the student teachers are introduced to the parallel communication and advocacy courses "some students in the instruction programme are not inclined towards the ideological approach of the advocacy option (this tends to be most true of returning teachers with established ties to the social system). Interestingly, P.M. Sandman adds the complementary observation that the advocacy component has existed for only two years, "and so far it is also our experience that students concentrating on environmental advocacy are reluctant to expose themselves to courses in curriculum planning and pedagogy.'

It is clear that the teachers of the Michigan programme have adopted a rather different view of the nature and purpose and a different balance of processes in environmental education than the English and French cases. The American case appears to demonstrate a more substantial and explicit involvement in management, quality, and participation issues at community level.

There can be few, if any, students being trained for a role in environmental education who are being taught by faculty who were themselves taught in environmental education courses. Therefore, a most important and fascinating question is how the present teachers of environmental courses formulated and embraced their present roles.

Initial teacher training in environmental education is quite widespread but a significant development has been the growth of award-bearing courses for serving teachers, the majority of whom return to schools. In the United Kingdoms there are, besides innumerable short courses, several Diploma courses. Two such are considered here, one a full-time course, the other part-time and thus recruited locally.

The University of Reading course is full-time and could recruit nationally. Features of this course characterise its interpretation of Environmental Studies in Education. There is little explicit information on course intentions, particularly in terms of effecting change in students. Cognitive approaches to interdisciplinary treatment are stressed. The ability and willingness of students to operate in such a way when they return to schools seems to be a main intention. To this end pedagogic aspects are also stressed.

This course exemplifies the common situation in which much of the teaching is contributed from a variety of institutions and departments by tutors who have other principal commitments in which they operate essentially as specialists. Such circumstances are not the most conducive to detailed curriculum planning especially at the more sophisticated levels made possible by modern educational technology, as the tutor notes in the case study.

Partly because of the interests at Reading there is a rural bias in the substantive course content, rather as there is at Northumberland. In this case, however, the treatment extends into the historical and geographical aspects The organising themes and concepts extend from "local history" to "energy flow" and "systems theory". Despite the macro-scale potential of the two last themes the concentration is on study at local and regional scales though not to the exclusion of wider issues.

As at Rennes and Northumberland fieldwork is stressed, especially the desirability of extended "team" fieldwork. It may be implicit in the interest in fieldwork that the socialising and motivating aspects are valued highly. Fieldwork has long been valued for a variety of learning experiences and particularly the chance to follow through the whole sequence of learning. It is increasingly being regarded, together with workshops, seminars, etc. as facilitating "integration". But it is not easy to find explicit descriptions of the product sought from integration. The Liverpool case study has a useful comment on this matter.

While the Liverpool course has community links derived from the local context of developed concern for community education, the Reading course has little learning in that direction. In general, social critique, "alternative socio-economics", and urban human ecology have so far made little headway in British courses. An interesting polarisation is expressed in the Reading case study - "the purpose is related to the needs of teachers who in turn are concerned with the needs of pupils, not of the environment". It is significant not only that it remains possible to isolate the two, but that this concept could form a basis for course planning. Note also the adjacent comment "a greater sense of responsibility is not considered to be of paramount importance" and the comparative inhibition of emotive responses to environmental issues. The contrast between the Michigan and British courses is affirmed.

At Liverpool the local setting, the characteristics of the team brought together from a number of colleges (the course organised has changed since the case study was made), and the professional interests of the team members induced more emphasis than is usual on social and urban topics, and on urban human ecology. But this was achieved without total sacrifice of biophysical themes and study of rural situations. In this sense Environmental Education is more widely interpreted than at Rennes or at Northumberland where the concept of "full-spectrum" courses was rejected on the grounds of consequent superficiality.

Despite specific differences, the Reading and Liverpool courses have much in common. They both serve teachers wishing, as the Liverpool case expresses it, "to undertake increased responsibility in--- environmental education" by considering especially the contributory disciplines, and curriculum study and pedagogy.

Both are dominantly rational-cognitive concentrating upon description and analysis of environmental situations rather than upon the "emotive" (Reading), and "unbalanced, quasi-religious, doomwatch overtones" (Liverpool). It would be valuable to know why in the United Kingdom there seems to exist a suspicion that value-education is, almost of necessity, to be equated with indoctrination. There appears to remain in Britain a viewpoint, now being reduced in strength, that to treat of values, critique, examination of alternatives, is likely to be undertaken to promote particular views, or that it will unwittingly result in the more favourable presentation of certain views, or that somehow personal autonomy may be inhibited.

Both these Diploma courses have received considerable thought. That they are representative of the award-bearing in-service courses is clear from the outlines of [illegible] courses. Of course, when public awards, particular target populations, kinds of offering institutions, and associated school systems are broadly similar then the scope for quite different innovations is reduced. This situation is also seen in the initial-training context where - given the twofold distinction between the more restricted "environmental science" courses and the wider "environmental studies" courses with their greater socio-cultural spreads - there is little radical variation among British programmes. There is (in Britain) little concentration upon preparing teachers to influence the processes of selecting values and choosing environmental behaviour among their pupils. Of the cases considered, it seems that Michigan concentrates a higher proportion of its efforts in that direction. The countervailing stress on the rational-objective and the quite widespread (but declining) matching failure to accept value education into environmental courses is in part a consequence of the hold that positivist philosophy has imposed on many scientists. It is interesting that many scientists quite conscious of environmental degradation sustain a detached pseudo-scientific view, or seek to treat degradation as a techno-biophysical phenomenon rather than a psycho-socio-economic one.

PROBLEMS AND POSITIONS

From the case studies and the commentary a number of issues arise which require further consideration. But it is characteristic of education that issues are inextricably inter-linked, that any one issue is part of the context of any other. The components cannot be isolated if the system is to remain whole. It is in this light that the education of teachers for environmental education will be discussed.

The first unifying point is the recognition that teachers are being prepared to undertake societal functions. The second unifying point is that by general inference environmental education is seen to form some part, at least, within general or liberal education. The Rennes study speaks of a country's needs ; Reading spoke of the "needs of pupils". It is clear that there are dual functions to be examined, that concerned with the individual, that focusing on the larger society. But it is quite obvious that if a proposition for some educational enterprise, in this case environmental education, attempts to respond to perceived needs, a situation of great complexity is revealed. Any society would produce a multiplicity of perceived needs. How are the claims of opposed needs born of different perceptions resolved ? For example, in many societies opposed functions for their schools based in crude polarisation upon "pay-roll" or "job-niche" orientation and upon "life-quality" orientation are articulated.

This position is further complicated by the addition of other relevant questions. The advocacy of various methodologies inevitably produces its own problems ,particularly of diffusion, conviction, and competence. This is still true of the most established of the newer teaching methods - practical fieldwork. The implications of disseminating and applying problem-solving and systemics in teacher education as well as in schools are hardly explored. Likewise the necessity for moral, political-economic-aesthetic components in environment education is still not universally acknowledged. It would not be difficult to find schemes that follow no planned intention to treat of personal values and interpretations and their formation, and to consider bases for personal and group "codes and behaviour". In this sense it may be ventured that such views of environmental education could be nothing other than partial. But if it is recognised that my behaviour and perceptions may influence my environment and my neighbour's, then it follows that so may my neighbour's acts influence my environment. And who is not my neighbour ? Environmental education based on this last concept would find it difficult, perhaps unnecessary, to draw impermeable boundaries against social and political education. What true education has no environmental implication ?

Moreover, in the context of definitions and propositions is there to be sought in and from environmental education a new orthodoxy or the discrete, diverse yet often enriching, generative qualities of heterodox approaches ? And if, as in the Michigan case, perception, behaviour, and value are central ,then the problem of how personal autonomy and integrity are to be protected is also a central issue.

Both of these problematic circumstances - orthodoxy or heterodoxy and how to treat values, etc. - from their existence at school level must extend into the preparation of teachers, and hence into the consciousness of the teachers of teachers. All this raises the problems associated with suspicions of indoctrination in the schools. This is so despite the constant explicit and sub-liminal indoctrination that permeates present society. At the same time it raises the question of how to offer support and a sense of identification to pupils when value-critique is being undertaken. The Michigan study shows that not all students are equally receptive to this aspect of their personal development, and, it may be inferred from other studies, there has been some general preference for non-purposive rational-empirical content in environmental education.

In a continuing education the possibilities and opportunities for appropriate curricula change with the ages of the pupils and it becomes clear that a progressive, cumulative treatment of environmental education is likely to be most effective, and this argues strongly for planned continuity. But it is also evident that any proposal for change in, or introduction to, a school curriculum is, in greater or lesser measure an expression of unhappiness with existing provision. It poses a challenge to an existing order of styles, structures, personal positions, methods, intentions, and often to means and locations of decision-making. When the innovations may themselves deliberately embrace the presentation of societal statements, the examination of values, and the acceptance of social critique, they may not ease their own paths.

In all this there remains the actual task of preparing and repairing teachers. This is being done and in the near future will be done by a body of people largely already active in this sphere. What are the characteristics of this body and the various institutions in which they serve ? Obviously, there have been vast changes in receptive institutions. New combinations of substantive content have been created in and between the humanities and sciences. A substantial debree of reorientation with stress on first-hand and discovery learning (often field and laboratory based) has taken place (though there is a suspicion that this has devalued the arts of expository teaching). All this is remarkable for it is being achieved by those who were not themselves educated in this way. It would be most valuable to know how and why many teachers have become willing and able to change in this way at this time. It may be that the somewhat eclectic bases of geography and ecology either attract that sort of person or dispose their students to develop in those ways, or both.

Even so, there is no uniformity of perception and intention among such educators of teachers. What is possibly quite general is that these people themselves sustained active and critical personal growth and appraisal.

It is clear that a broadly-based environmental education is likely to call upon a wide range of content and of epistemological styles. The 1972 "Bossanyi proposals" (1) exemplify this comprehensively. Where a course is of the Northumberland type internal coherence is encouraged by the dominance of sciences utilising fairly similar rational-empirical styles. But, when the course extends more widely and also embraces the "value-social critique" dimension the situation may be quite different. In such a case a teaching team would encompass greater variety and the students (the present or future school teachers) would be expected to operate in a range of ways possibly greater than any individual member of the teaching team can apply. Thus there is created potential for stress generation within the teaching team and within the individual student upon whom great demands would be made.

This last point may be exemplified by considering a way of describing an individual's epistemological - value position at any one

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1) Mimegraphed document, unpublished.

period of time. For example, by disposition or by experience a person may have become wedded to and practiced in the rational-empirical epistemology of the sciences and have developed a personal value construct dominated by theoretical-cognitive concerns - or may have become practiced in, say, the intuitionist epistemological processes and informed by concern for aesthetic values. Two points arise. We rarely consider such characteristics of individual members of faculty when trying to assemble teams to do particular jobs. We rarely consider the epistemological - value demands of our courses especially the newer transdisciplinary offerings. Both substantive content and affective course intentions carry implications for the varied characteristics of students.

It seems usual that when a group of innovative teachers develop a wide-spectrum course then the content is divided for teaching among the team. Granted, team members combine to elucidate and expound particular circumstances e.g. in the field. However the students generally younger and less-experienced, are expected to cope with the whole spectrum of the course, and to produce by some means or other what are called "integrations". In order to progress generally beyond multidisciplinarity the questions arise : how and when are potential teachers for environmental education to be identified ; what are their characteristics ? If the role and form of environmental education is to vary with the ages of the pupils it may be sensible to concentrate in teacher education on skills and characteristics appropriate to the age ranges that particular groups of teachers are preparing to teach. If environmental education within the secondary schools is thought to be best served by a unified course and organisational structure the question of who teaches what remains. How is environmental education best related to other bases for value education e.g. religious education ? Are there optimal structures for a coherent treatment ? It seems obvious that "Rennes and Northumberland type" courses would identify suitable students with greater certainty than courses which are founded on a greater range of perceptions and activities. This would be particularly true in relation to students from those schools that develop remarkably uneven epistemological profiles among the older pupils. In any case varied responses from school pupils to environmental education are expectable on the basis of inherent and learned individuality affecting preferred learning styles, and value perferences.

One consequence of several is that no uniformity in "end-product" of environmental education is expectable, particularly in affective development. This is a point which requires emphasis in teacher preparation, being crucial to the distinctions between education and instruction, between performance-specification and personal "becoming".

The education of teachers in these matters is obviously a matter of great importance and complexity. It is clear that a course of preparation for teachers (and similarly their courses in their schools) may be concerned to widen repertoires of understanding and potential behaviour, and to effect perceptual reappraisals. That is, its concern is to extend the basis on which a student builds a personal epistemological-value position. Naturally, there may occur strain between a position brought by the student to the course and the intentions of such a course. This is one point at which support and guidance may be needed. Faculty should be aware of potential consequences of what they are trying to achieve.

The choice of substantive course content is not unconnected with value education, in so far as it represents selection of material and interpretation of needs. The same is the case with any sequences and structures proposed for the treatment of content. Content can be treated in different ways to different ends ; realisation of this and its implications is part of the education of teachers.

It seems probable that the present diversity in the ways teachers are being prepared for environmental teaching is even greater than the case studies reveal. It will also be obvious that the "multi-institutional, many and part-time teacher courses" face real difficulties not only in putting together substantive content but in coordinating purpose and the ones for whom such arrangements are necessary.

The preparation of teachers for environmental education involves a number of elements which exist in a continuum. These include :

1. Their education in "environmental" matters,
2. Their education in pedagogic and curriculum matters,
3. The nature of proposed innovations for schools, etc. where they will teach, and
4. The receptivity of the schools.

Obviously, frustration will be generated if teachers are prepared for functions that schools recognise neither as appropriate nor opportune. So the development of an acceptance of environmental education must proceed on a broad front. In this respect it is interesting that, in Britain at least, some school courses have been more adventurous than have the teacher-training courses. Certain questions must be raised again. Firstly, what are the respective merits of building up a new orthodoxy for environmental education or of encouraging the generation and exchange of ideas possible in a climate of diversity ? The summary of various interpretations of environmental education presented in the Liverpool case study as well as the case studies themselves demonstrate a degree of existing heterodoxy. The discussion must embrace a second question. The function of teacher education is to influence the education of pupils through the preparation of their teachers ; what, then, are the implicit or explicit views which will inform environmental education of the appropriate development of young people (and their teachers) in a particular society ? Will there be a "right" answer ? In terms of the general education of the bulk of citizens it has been inferred that the only real meanings to be gained from environmental education are affective. These might include identification with and affection for a locality (probably local, possibly global), a desire to influence the behavioural trends of society from a position based on a sufficient and rational understanding. Cognitive understanding alone is not a sufficient basis for selecting and influencing environmental behaviour. Conflicting opinions can have rational bases. Thus the reality of "value-free" environmental education is challenged. But, on the other hand, values involved are often in opposition at both personal and societal levels. It remains necessary to discover more about how to encourage popular understanding and acceptance of global responsibilities, and probably it is not coincidental that many courses tend towards local scale treatments.

So it seems that the development of any effective curriculum for the education of "environmental" teachers requires the planners to clarify their intentions in terms of change to be effected in the learners (the school teachers) prior to selecting appropriate content. Not only would this place personal "becoming" before the specification of material to be learned, but it may permit the development of alternative routes to "becoming". It is, for example, conceivable that routes could be initiated through literary or sociological studies, etc. It is also conceivable that different preparatory courses, at least in part, would be appropriate to teachers of pre-adolescent, adolescent, and older pupils.

It would be expected of all those teachers that they had, at least, been introduced to the business of curriculum development, that they did not suppose substantive content to be the only essence of their courses. Given that condition it would also be expectable that their own teaching in schools was not based on the supposition that selected content is value-free, and unrelatable to intentions expressed in terms other than cognitive.

It would be possible if space were unlimited to enquire more deeply into other important issues in environmental education. These centre on the variety inherent in any group of teachers, and possibly greater in those atracted to broad-spectrum courses than in those drawn to the more specifically science-based programmes. There is also the variation in willingness or otherwise to engage in innovation. Additionally there is variation in acceptance of and confidence in handling controversial issues, together with variation in respect for pupils' integrity in such circumstances. It seems obvious that any environmental course will have heterogeneous outcomes. Thus, assessment of programme success is not susceptible to easy determination. The description of intentions and the processes of evaluation are closely linked. It would be expected that both these aspects of teaching would form part of the education of environmental teachers.

Many teacher-education courses in environmental studies, as the case studies demonstrate, look for integration to occur in their students. Presumably the hope is that these students shall, in turn, teach for integration. It is easy to suggest that student-teachers should integrate. Less easy to discover are adequate descriptions of the product of integration, and strategies for accomplishing it (see Interdisciplinarity : Problems of Teaching and Research in Universities, OECD 1972). Both descriptions and strategies are necessary if the teacher is expected to facilitate and evaluate integration. What has faculty to say of a constructive nature about this ? If integration is to be at the heart of broad-spectrum environmental courses who is suitable to become an integrator ? How is a potential integrator detected, nurtured and improved ? Is there some inherent predilection to integrate ; is there some necessary prior experience ? By the same token who is best suited to teach the teachers about and for integration ? Really there is not a lot of substantial information on these points. Nor does there appear to be much on method and success in interdisciplinary teaching of younger children. The Liverpool case study makes a valuable contribution to the consideration of integration, and it may well be that the recognition and treatment of problems, topics, or issues on a system-wide basis are precursors to successful integration. Even so, some idea of what, in any context, successful integrations comprise is necessary before a pedagogy is selected. Similarly to discuss in detail appropriate pedagogies for environmental education courses i.e. how and when to team-teach, engage in field work etc., must require some consideration of intentions in a fairly specific way.

Much has been written about the content of environmental courses in general ; the OECD's Environmental Education at University Level : Trends and Data, 1973, gives many examples. Despite wide variation in content, sequence, and approach it becomes quite evident that a teachers' course in environmental education is likely to draw on a broad range of knowledge and will, whatever its content and structure, transcend monodisciplinarity. Thus, student teachers will meet several modes of arriving at conclusions, hypotheses, or theories, encounter various degrees of probability, meet weak and strong arguments and propositions. They will employ many ways of gaining and appraising evidence. In meeting unifying themes and major organising concepts, e.g. systems analysis ,they will conjoin the methods of various disciplines. It seems imperative for their own intellectual growth and for their own subsequent teaching that the nature and implications of a multiple epistemology should be thoroughly demonstrated and articulated by their teachers. That not all students could be comfortable in such a multi-facet situation has already been inferred. That environmental education is likely to be congenial and suitable for a certain type of personality follows.

This survey has avoided making propositions and presenting specifications for teacher education. The case studies do this and Conference recommendations present broad guidelines. It has been considered more appropriate and necessary at this stage to enquire into the problems that arise when it is proposed to prepare teachers for "environmental" teaching. There are many open issues ; there is scope for various interpretations, and need for more evidence of what is possible, and what may be desirable. There is much to discuss, much to clarify, and, possibly, no necessity for convergent thinking, at least, on all matters. What is important is to note that the interconnectivity within preparation for environmental education demands a connectedness in thinking and planning that matches the complex demands of the task.

The five case-studies [*] used in the review presented in Chapter 4 come from the following institutions :

Environmental Protection Agency,
Washington D.C., United States,
by J. Bahnick.

Environmental Studies Programme,
University of Indiana, United States,
by C.E. Nelson.

Florida Resources Analysis Centre,
Florida State University, United States,
by E.A. Fernald.

Information Seminars for Senators of the Republic,
Rome, Italy, by V. Giacomini.

Course on Environmental Policy,
Pro Deo Free International University
of Social Studies, Rome, Italy,
by B. Giacomini.

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[*] Case-studies published in : Environmental Education at Post-Secondary Level (2): Courses for Educators, Decision- Makers and Members of Professions concerned with the Environment, OECD/CERI 1974.

Chapter 4

COURSES FOR DECISION-MAKERS

by

V. Giacomini, Director of the Botanical
Institute, University of Rome, Italy

INADEQUACY OF INFORMATION AT POLITICAL AND ADMINISTRATIVE LEVEL

The problem of the proper relationship between the political and administrative authorities and the environmental scientists has recently become very important in a number of countries. The solution most frequently proposed is to set up ordinary or extraordinary committees to help, advise and inform these authorities on specific problems.

However, there is no active involvement of universities, research centres, standing committees or qualified scientists with a view to giving the men at the top a greater awareness and a deeper personal knowledge of these important and complex environmental problems in their most serious and fundamental form.

Very seldom is it suggested that these authorities should be kept systematically informed through regular meetings of the general fundamental concepts of environmental problems in a country or region in the wide context that ecological issues require. We do not need to emphasise the potential importance of a general realistic approach using ecological information i.e. based on practical problems of land use. Politicians and administrators have indeed received a cultural, legal, sociological or economic education but seldom a scientific training and even less frequently an ecological one. In addition, they do not have an opportunity of keeping up-to-date with developments in basic knowledge, which might sometimes have a decisive influence on their opinions and decisions.

A question that has remained unanswered was asked at a Plenary Session of the 1970 Strasbourg Conference on Nature Conservation : "Who will brief the politicians on ecology ?" This is not a riddle but an issue on which all citizens convinced of the complex nature of environmental problems are entitled to express their opinions.

This complexity affects all aspects of social life and all economic activities and the matter cannot be left in the hands of decision-makers who do not have a fairly broad and integrated view of the problems. The tendency to entrust environmental protection to a special authority - a ministry, an agency, a specialised department - certainly ensures a functional efficiency, but is not sufficient to encompass all problems ; it does not entitle other government authorities to remain unaware of ecological problems which involve all sectors of public administration without exception.

But this is an open question. Attempts to obtain information on this subject from the various countries have not been very successful. In short, this means that the question has not really been tackled and that we are still far from achieving a satisfactory solution.

We may even say that the problem has not, as yet, been rationally stated. Its importance is acknowledged, it is agreed that politicians should be more effectively informed, but there is no attempt to propose positive solutions (cf. for example : R.A. Charpentes, The political use of ecological information, Bioscience, 20 , 1285, Washington 1970). It is precisely the proper use of ecological information that becomes questionable and doubtful if those who have to use it do not understand even the most elementary ecological argument.

CASE STUDIES

There is not a complete lack of information about decision-makers. Five papers have been submitted to us which differ quite considerably and give rise to a number of considerations.

a) The first case study comes from Joseph Bahnick, of the U.S. Environmental Protection Agency. It deals with a series of 17 three-day seminars organised by the League of Women Voters. This study is noteworthy because it is based on a long-term experiment which has led to the creation of very sound "training" structures. The shortness of each course is not a negative feature in view of the aims of the courses and the very careful preparation which preceded them. The declared aim is not to train environmental experts, but rather to promote a better understanding of the size of the problems and the interrelationships between social and economic factors in the environment. The preparation necessitated the setting-up of a Planning Committee assisted by several sub-committees. J. Bahnick's paper is very detailed and most interesting.

b) The second case study is taken from Italy and concerns a course on "environmental policy" for decision-makers organised at the Pro Deo Independent University, Rome. This course has been in existence now for three years and is making satisfactory progress.

The teaching structure has become increasingly complex. In its third year, 1974, the course will last three months,comprising more than 100 hours of lectures given by more than 40 teachers, experts and representatives from research, technological and conservation establishments. As the Pro Deo University is oriented towards social and economic studies, multi-disciplinary information effort is interesting, insofar as it starts from the basic ecological information provided by botanists, zoologists and geochemists and goes on to study technical, sociological, and economic questions. This is a university venture reminiscent of a similar activity undertaken in 1963 by the Free University of Brussels and in particular by its Sociology Institute,which devoted a XXXth University Week to a series of lectures under the general title Nature, Ressources Naturelles et Société (Nature, Natural Resources and Society) which were published in 1963 under the same title by the "Editions de l'Institut de Sociologie". The Brussels example could be considered as a case study in its own right : it was based on 3 conferences and 23 courses. However, if we examine the list of the 200 or so participants we see that it was not really designed for decision-makers, who are in the minority compared with professionals concerned with the environment, teachers, students, technologists and persons wishing to extend their knowledge.

The fact that university seminars are open-ended means that they are often less specialised and less practical ; they run the risk of becoming formal and cultural.

c) The third case study is the environmental studies programme at the University of Indiana (Bloomington) and is submitted by Craig E. Nelson. The interdisciplinary nature of this case study is due primarily to the collaboration of three departments : Microbiology, Political Science and Physics (1965). Specialised courses were developed : Environmental Control, Environmental Biology and an experimental course with the title "Man and Environment". A distinctly more formal programme was introduced in 1970, following a meeting of the Faculty of Science. But more important still was the decision made in 1972 to set up a School of Public and Environmental Affairs (S.P.E.A.) operating an environmental studies programme, an urban affairs programme, an Aero-Space Applications Research Centre, and a programme on Science, Technology and Public Policy.

The most important orientations or specialisations for our purpose are :

i) an "undergraduate Concentration in Environmental Policy", for students aiming at a "Bachelor of Public Affairs" degree ;
ii) a "graduate Concentration in Environmental Policy" for students aiming at a "Master of Public Affairs" degree.

The first programme is based on three levels of specialisation leading to three certificates. The second programme is divided into two levels ; the higher level, leading to the Master's degree in Public Affairs, requires courses in the dynamics of Environmental Systems, political, economic and regulation aspects of Environmental Control and applied ecology.

The most interesting features of the Programme as a whole are :

- the professional perspective,
- reference to a specific area (a territory or a State),
- practical work associated with professional training,
- interdisciplinarity ensured by numerous departments (Biology, Zoology, Geography, Physics, Political Science, and Economic Science) thus making maximum use of all that existed previously,
- although an integral part of the University, the Programme is linked with several extra-mural committees, associations and institutions,
- a total systematic approach based on a fundamental ecological view applied to economic, social, statistical and management perspectives.

The example provided by Indiana University is certainly the most advanced and the most closely linked to the training requirements of students intending to take up employment in public or government administrations. It is thus concerned with the effective, systematic preparation of future decision-makers.

From the experience gained with this programme, E. Nelson considers it desirable to improve the integration processes. The multiplicity of courses given by members of different faculties chiefly encourages general preparation. He would like to see several faculties involved in each course. He also stresses the need to support the practical nature of the courses by developing case studies and retraining projects on environmental management and improvement.

d) The fourth case study is the experiment carried out by the Department of Geography, University of Florida, which set up the "Florida Resources Analysis Center", in collaboration with certain State Government Departments. The Centre has many objectives : research programmes, information on complex problems, and also - which is of particular interest in this context - the training of State civil servants qualified in resources management.

The outstanding features of this action are :

- very wide co-operation with State agencies, government departments and legislators ;
- the desire to increase and improve the qualifications of persons who will be involved in urban and regional government ;

- instruction given is not only by teachers but also by several government authorities and environmental specialists acting as "guest lecturers" and "consultants" ;
- encouragement for increasing communication between State agencies which need research and university research institutions ;
- a high degree of flexibility enabling the Centre to adapt to the changing needs of education and research.

The aim of training future decision-makers is quite clear. The organisation itself is very practically and flexibly adapted to this end. Emphasis is given particularly to courses on ecology, regional and urban development, conservation, land use, resource economics and law. Practical work is predominant in the preparation of the thesis : the subject of the thesis is a piece of research proposed by the Centre with the agreement of a State agency and thus comes into the programmes of public interest.

The programmes of the Indiana and Florida Universities have several features in common : their practical nature and the trend towards the study of real cases. However, it would appear that the Florida University Centre is more careful to counterbalance the deductive method with the inductive method.

It is also interesting to note that the Florida University Centre leaves the final evaluation of the activity and the professional evaluation of the participants to an extra-mural assessment consisting of the appraisal of a period of practical work performed in a government agency.

The vocational emphasis is very marked and would enable this experiment to be linked, on certain points, with the education of professionals concerned with environmental problems.

e) The fifth case study is an example that might be regarded as more exceptional : it concerns the action taken in 1971 by the Senate of the Italian Republic, through its President, Amintore Fanfani. This case study is concerned with decision-makers at the head of a country's institutions and particularly difficult to involve in regular multidisciplinary seminars. The confrontation of scientists and experts with senators must be regarded as a unique occurrence which has not been repeated in subsequent years, even in Italy ; it is questionable whether the experiment succeeded in achieving its objectives. The most interesting effect was the political impact it has on the press and, as a result, on public opinion in Italy. The few seminars involving senators, scientists and technologists did, however, open a new channel of communication and efforts should be made to develop it more effectively.

Apart from the case of the Senate of the Italian Republic, we might mention a much less well-known experiment which is being carried out in the Chamber of Deputies in Italy. It was decided not to organise the same sort of seminars as in the Senate. It was considered preferable to organise an information effort, the results of which are synthesised and distributed specifically for the use of Deputies. A committee of seven experts has met several times to draft the chapters of this text, with the aim of linking them together so as to form a basic framework of information on environmental problems in Italy. This experiment indicates quite a significant possible course of action, but it has the disadvantage of abandoning more dynamic and more human encounters and direct debates. Apart from this, it does lead to more extensive information and greater awareness in the consideration of problems.

A comparison of these five case studies and the relevant experiments leads us to the conclusion that they represent quite different approaches to the problem of informing and training decision-makers :

i) the experiment developed on the instigation of the League of Women Voters is of an eminently practical nature focussing very specifically on the water and soil problems in a particular region. It is hoped, here, to encourage multidisciplinary confrontations and workshops in order to promote an organic action of environmental development ;

ii) on the other hand, the experiment developed by the Pro Deo Independent International University of Social Studies in Rome is designed to impart more general information with a view to overall consideration of environmental problems - a synthesis rather than analysis of the problems. The fact that this seminar lasts longer means that specific aspects of particular importance may be approached ;

iii) the two examples provided by the Universities of Indiana and Florida reveal a more systematic involvement of the University in the problems of the training of future decision-makers. In contrast to the Pro Deo University experiment these courses are more particularly aimed at students and concentrate more on practical instruction ;

iv) the action taken by the Senate of the Italian Republic is an experiment in information, directed at a level which is much more inaccessible to systematic information approaches ; it shows that it is possible to open channels of communication at the highest level of decision-makers, either in the form of seminars or the well-organised distribution of documents.

GENERAL CONSIDERATIONS

Comparison of these different case studies enables us to put forward some general considerations in the matter of informing decision-makers. We can first of all point out the common concerns of the five cases :

i) the desire to work on a multidisciplinary level and thus reveal the dangers brought about by any form of compartmentalisation, especially among ministries and high-ranking officials ;

ii) the organisation of information related, as far as possible, to facts ; even if the starting-point is theoretical and fundamental (example of the Pro Deo University) a practical approach based on real situations is gradually achieved ;

iii) the tendency to give maximum attention to human interests (economic, sociological, political) ;

iv) in-depth preparation which often (especially in the case of the League of Women Voters) means a long-term, highly complex involvement ; this is the most important condition for success ;

v) the tendency to follow up conferences with workshops, exchanges of opinion, discussions ; this is the beginning of contacts between different competencies, which it is hoped to promote permanently. The tendency to set up permanent structures (committees, institutions, links between existing institutions) after seminars often appears automatically ;

vi) the tendency to encourage the concentration of competencies on practical problems of integrated land use.

All these points may be regarded as priority considerations in these five studies.

However, these five cases also suggest differences of orientation relating mainly to the section of the public concerned. We can identify three levels of practical significance :

i) students i.e. the future decision-makers ; the Universities of Indiana and Florida in the United States are especially concerned here, as they operate degree courses for students planning a civil service career ;

ii) in-service decision-makers : especially civil servants, public administrators, those in charge of energy productivity and primary resources. The League of Women Voters experiment is an original and effective response to this sort of demand. Having abandoned the global and fundamental perspective, it adopts an eminently practical approach encouraging links between different interest and responsibility groups with the aim of creating the fundamental conditions necessary for any environmental planning based on ecological methods and principles ;

iii) decision-makers exercising the highest political authority. It has been stressed that this is the least accessible group. The experiments in the Senate of the Italian Republic and the Chamber of Deputies enable us, however, to envisage some possibilities for the future, particularly the organisation of more frequent communication between scientists, environmental specialists and the highest authorities of the State.

All these experiments also reveal some uncertainty concerning the best methods to adopt to obtain the most satisfactory results. We suggest a choice between the following alternatives :

a) Undergraduate or postgraduate courses leading to a professional degree or a specialised qualification ; this alternative also covers the training of professionals involved with the environment. The possibility might also be envisaged of establishing a specialisation in social technology of the environment. A diploma in this special subject might be conferred on future decision-makers responsible for studying the problems of the interrelationships between the processes of productivity and the conservation of environmental quality ;

b) seminars dealing with regional conditions or certain problems of particular importance. These seminars may be more successful insofar as they aim at encouraging links between groups of different skills ; however, they provide a flexible short-term means of informing decision-makers who have little time to spare and would refuse to become involved in lengthy commitments. They also provide an escape from formal or too theoretical atmosphere ;

c) the inclusion of subjects relating to ecology or the physical, biological, and human environment in existing professional courses especially in Departments or Faculties of sociological and economic studies. We feel we must strongly urge that this be introduced into the systematic training of future decision-makers, in order to make them more aware of environmental problems.

These aspects and requirements may be briefly summarised as follows :

- the need for systematic and recognised training of future decision-makers at university level ;

- the need for specific information on particular local or regional problems aimed at those currently responsible for public interests ;
- the need for an increased awareness and deeper knowledge of basic environmental problems in official circles (administrative or governmental) where ideas on the subject are often inaccurate or out of date.

To deal with these needs, appropriate methods and instruments are required. It would be regrettable if the different aims were merged with general purpose activities liable to give only illusions or presumptions of "ecological" competence. Meaningful degrees indicating the professional qualification of decision-makers should be awarded only after sound preparation through undergraduate or postgraduate courses.

We should also stress, in this context, the importance of a period spent working in a Government Agency or in a private establishment which enables experience of the real problems of land use to be gained. The experiment carried out at the University of Indiana deserves special mention in this context.

The scarcity of available documentation on the information and training of decision-makers confirms our conviction that this aspect of environmental education is far from being solved satisfactorily. I would even go so far as to say that the majority of countries are not aware of the problem. But in view of its great importance it is absolutely essential to assert the need to increase and broaden experience. We must advance beyond the stage of occasional seminars and develop more significant, permanent methods suited to the real needs of the different levels of decision-makers and to regional situations, to which reference should always be made. A weak point in the training of decision-makers is, in fact, the lack of knowledge about the physical, biological and human differences existing in a country, that is to say, about regional differences in the ecological sense.

The five case-studies* used in the review presented in Chapter 5 come from the following institutions :

Environmental Education for the Health Professions,
Ecole Nationale de la Santé Publique, Rennes, France,
by J.S. Cayla.

Ecosystem dynamics, College of Engineering, Michigan
State University of East Lansing, United States,
by H. Koenig and E.D. Goodman.

College of Environmental Design, University of California
at Berkeley, United States,
by W.L.C. Wheaton.

Department of Family Medicine, Michigan State
University of East Lansing, United States,
by S.M. Johnson.

The Environmental Quality Management Programme,
Division of Environmental Health Sciences,
School of Public Health, Columbia University, United States,
by G.H. Sewell.

In the discussion these five programmes will be known respectively as :

Rennes
Michigan Engineering
Berkeley
Michigan Medical
Columbia

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* Case studies published in : Environmental Education at Post-Sec[illegible]ry Level (2): Courses for Educators, Decision-Makers and Members of Professions concerned with the Environment ,OECD/CERI , 1974

Chapter 5

COURSES FOR MEMBERS OF PROFESSIONS CONCERNED WITH THE ENVIRONMENT

by

P.J. Newbould, School of Biological and Environmental Studies,
The New University of Ulster, United Kingdom

INTRODUCTION

Professionals in the context of this paper are such people as planners, architects, landscape architects, engineers, lawyers and doctors. In some countries such as Britain they come under the aegis of a professional institute which approves or directly awards their qualifications, issues codes of practice and generally oversees the conduct of the profession. In more general terms they are people who (a) bear independent analytical and judgemental responsibilities and (b) possess a qualification, usually approved by some regulatory body or recognised educational institution. A post-secondary education is usually implied. The training of professionals is often long and arduous. The subject matter and skills involved have tended to increase rather than decrease, so that the training programme of professionals has become increasingly full.

At the same time new environmental awareness has shown that professionals cannot work in isolation and that their professional work has broad environmental implications. Team work involves some knowledge of the vocabulary and concepts of related specialists. Therefore it seems desirable that there should be some element of environmental education in the training of all professionals. The aim of this would be partly to convey a general environmental orientation but also more especially to allow professionals to assess the possibilities of their own professions for reducing or mitigating man's environmental impacts. The present analysis aims to examine how this might be achieved, drawing on particular experiences in this area.

At the start it is worth thinking how professional education may differ from other forms of tertiary education. The syllabus is of necessity already very full. The syllabus and examinations are sometimes set by people or institutions other than those responsible for teaching them. Professional education and certification may carry added responsibility in the sense that professional mistakes resulting from faulty education are likely to be expensive or fatal or both. At least some of the teachers are likely to be in professional practice themselves, giving them greater contact with reality but also perhaps less time for teaching and research than other academics have.

WHO DOES THE TEACHING ?

Questions of the institutional basis and of who does the teaching tend to overlap. Three main situations can be distinguished. Take as a hypothetical example a Department of Planning in a university. The planning students could get their environmental education by attending courses in other factulties of the university. Many American universities allow plenty of scope for students to take elective courses from other faculties. So the student of planning could take a unit of water resource management and a unit of elementary ecology. Such units will be taught by experts from a strong department. They will probably not be purpose-designed for planning students and they may not relate well to the needs of these students. After they will be optional. This strategy, however, does represent economical use of staff time.

The second situation is where the planning department invites a lecturer from the biology department to come and give a course, or some lectures, on ecology to the planning students. Here the lectures may well be compulsory, and will be purpose designed. But the ecologist giving them may regard them as a chore divorced from his main job ; they may be passed down to the junior member of the biology department. Incentive for providing them may be weak.

The third situation is where the planning department appoints an ecologist to its staff, and he lectures to the planning students on the ecological aspects of planning. He will come to understand very well the needs of the planning students and he will have incentives to do a good job. The opportunities for interdisciplinary teaching, for developing dialogue between planning and ecology will be good. But an ecologist in this position may feel himself isolated from a research base and from other ecologists. His promotion opportunities may be diminished. He can never become head of a planning department ; he may not be able to do enough ecological research to move back to a biology department. And if he stays for more than, say, ten years, his ecology may become stale. This strategy requires a fairly large planning department which can employ, as in the example, an ecologist and presumably also a sociologist, an economist, a lawyer, etc. Some of the posts will be difficult to fill because they are unattractive to the research-oriented scientist and there is the danger than only a non-research-oriented, second-rate, scientist can be recruited.

The five case studies discussed introduce a range of possible mechanisms. In general most of the departments concerned appear to include most of the teaching they need within the department, i.e. the third option set out above. This may be because the case studies are the best of their sort. However, at Columbia for example, some courses (e.g. basic geography) are taught outside the School of Public Health (that is,elsewhere in the University) and others like air pollution, water pollution and solid based management are taught by bringing an outsider in, though it has proved very difficult to find anyone to teach environmental economics. All five case studies mention the importance of personal commitment when recruiting staff. Most admit that research ability is rated and rewarded more highly than teaching ability in making an appointment. This may not be just as true in medical education. Such excessive emphasis on research is often resented by students. In the general area of professional education there is a three-way pull, not just research and teaching but also consultancy or other professional activity. Some faculty members may find they have little time left for their teaching. Several institutions employ professionals from outside the university to help teach the course and find this beneficial, but sometimes quite difficult to co-ordinate. At Berkeley about seventy-five full-time faculty members are supported by fifteen full-time equivalents of part-time teaching, meaning thirty to forty part-time appointments and they judge this ratio about right. They try to involve them, as do some of the other institutions, in course development but are not always successful in this. No-one finds it necessary for all the teaching staff to have the professional qualification they are teaching for,though some of them should have it. Only Michigan Medical mentions direct evaluation by the students and then it is only of programme content rather than of lecturing skill.

INSTITUTIONAL ORGANISATION

The diversity of institutional organisation makes generalization difficult. Furthermore few people have much effective choice about institutional organisation. People seeking to achieve curriculum innovation are usually saddled with their own particular institutional constraints. Also the institutional bases for professional training are in most cases already well-defined and not amenable to much alteration. General points coming out of these case studies are :

i) everyone is or feels himself to be short of money ;

ii) varying degrees of democracy exist. Some Deans still exert considerable influence which puts a large chance element into curriculum innovation. The enthusiastic and energetic innovator can achieve a lot in most institutions ;

iii) while several departments have good links with agencies outside the University and get outside help in teaching their programmes, in general the outside links other than professional institutes, have little formal role in curriculum design ;

iv) levels of co-operation between departments vary but are generally good where there is sound academic logic behind the co-operation sought ;

v) arrangements for counselling of students vary. Anyway it is difficult to determine the success of different arrangements.

COURSE CONTENT

Again, the subject areas and professional qualifications of the case studies are so diverse it is not easy to generalize. The selection of the case studies is based on their environmental content being more extensive than would normally be the case in professional training, i.e. they represent the best of their kind. The whole educational process has a high inertia and is slow to change. Professional education, overseen by the busy top men in the profession concerned, is very slow to change. The problem is that the curriculum is usually over-full and it is difficult to throw out enough of the existing content to make room for new material. However, some professions and some institutions manage to do this which should be an encouragement to the young reformers who can be found in most professions.

It seems clear that there are at least four necessary components :

a) Some multidisciplinary orientation which is the essence of an environmental perspective. This orientation is necessary to ensure an adequate scope of subject concern and the ability to communicate with other professionals ;

b) For professionals with a responsability significantly involving the environment, the educational process should also include extensive, in-depth training in a subject or skill related to the control of environmental problems ;

c) If the professional is to be given responsabilities for coordinating, managing or synthesising the efforts of other professionals in the environmental field, a third educational component consisting of broad but rigorous training with environmental systems is required ;

d) Systems analysis and synthesis. Most professionals will have to deal with information relating to four very different types of systems. These are social and human systems (especially since professionals must always seek to involve the public in their activities), ecological systems, management and information systems (especially as professional judgement must relate to the decision-making process) and technological systems.

In the medical training at Rennes, the extra material is on epidemiology, on the understanding of the physical environment and on ways of influencing it and it does take a substantial proportion (up to 23 per cent) of the training time. The Michigan Medical case study is concerned especially with family planning and population limitation. While the programme ,goes thoroughly into demographic aspects of population growth it does not appear to explore the broader aspects of environment and resources as related to population growth. The third medical programme,that of Columbia, contains much material concerned with environmental quality control. The content taught here goes especially into theoretical and practical aspects of pollution, its assessment and control and there is certainly a broad environmental coverage. At Berkeley the architecture, planning and landscape architecture degrees are all at the graduate level following on a liberal arts type of undergraduate programme which allows, but does not ensure, some environmental training. Within each major theme there is a high degree of specialisation and a fair degree of choice. Within the College of Environmental Design there is deliberately no emphasis on natural ecology which is taught in another college. It is held that "each of the professions is already interdisciplinary in content to the limits of teachability and that therefore it is preferable to maintain a larger environmental bias within the established professions". The picture seems to be that of a large institution with a good range of environmental options and little compulsion. One problem which may arise from a high degree of student choice is the general conservatism of students and the fear that it is the more blinkered students, most in need of environmental breadth, who are least likely to avail themselves of the breadth available. There seems also at Berkeley to be an element of constructive discussion, disagreement and compromise between the professional institutes.

At Michigan Engineering the aspect of course content relevant to this discussion is the unit on ecosystem analysis.....Students in Biology and Engineering work together in small teams to develop ecological models in fields of their own choice, having first been given sufficient background in systems concepts (for the biologists)and biological and ecological concepts (for the engineers). The unit seems popular among students and faculties. The models are constructed in FORTRAN because the engineers are already familiar with this and the biologists have learnt to use it in their preliminary course. This seems to be a fairly small and simple innovation inserted into an existing programme and to be very effective.

In summary, of these five institutions Columbia is less afflicted than others by professional constraints and can therefore produce a broad well-integrated environmental programme. Michigan Medical does not achieve very much broad environmental input. Berkeley, by the size, breadth and excellence of the institution, offers the students a good choice of environmental subject matter. Rennes has injected a suprising amount of environmental material into the medical profession and Michigan Engineering has produced a rather small but seemingly very effective unit of ecology for engineers. Apart from these examples of initial training it is clear that there is a massive retraining programme needed and a number of University extramural departments are beginning to operate in this field. Possible areas for further discussion include how to outwit, infiltrate or overthrow professional constraints where these are both constrictive and conservative and how to achieve some environmental breadth without diluting professional depth (the Jack-of-all-trades-and-master-of-one).

TEACHING METHODS, MEDIA AND MATERIALS

It is only necessary to look for ways in which the environmental aspects of professional education differ from the generality of university education. Lectures, seminars and laboratory classes are general ; so is the use of slides, tape, CCTV, film, etc. Student progress is monitored by various sorts of tests, essays, etc. Other aspects of teaching methods and materials, such as the use of self-study units, student access to computers, the extensive use of photocopied scientific papers,etc. ,are less universal but they are not a special feature of professional training.

The breadth of subject matter in professional education creates problems of integration and interdisciplinarity. Integration is achieved partly through discussion between the various lecturers involved, partly by the student himself especially if he is a graduate or final year undergraduate and partly through the case-study, problem-solving approach. This latter is probably the most important and distinctive feature of environmental professional education. The case or problem studied may be imaginary (as sometimes in the games approach) but is more often real. It may be an analysis of past events, sometimes something drawn from the professional experience of one of the lecturers. But alternatively it may concern some current live issue in the local community in which case the student solution, if well supervised, may itself be of value to the community or may form the basis for a more extended research project. A project in which the students play a real and important role gives great encouragement to them, making them active partners in their university and breaking down the teacher/taught barrier.

There seems little doubt in general that focusing down on real-life problems as teaching material is beneficial in providing motivation for students, community involvement for the university and the opportunity to integrate interdisciplinary approaches and for the students to learn about teamwork. There is a danger in narrowing down on too specific a problem and it is important that it be set in a broader, often global, context. Often too all the students are training for the same profession, so the full breadth of team work is not realised. It is not so easy to set up at student and faculty level a planning team involving planners, architects, engineers, sociologists, economists, ecologists, etc. The problem based approach allows the university to bring local managers, politicians and civil servants into the discussion. Several of the case-studies mention the systems approach (see also page 128) and the use of computer simulations. Michigan Engineering suggests that the ideal group might include four students and two faculty and might meet once a week.

Since most professional training already involves real world project work of some sort, the important thing is to ensure that the project work carried out does deal adequately with broad environmental aspects. This is generally so in the case-studies under review but is not necessarily true of most professional training.

THE RESEARCH BASE

All university lecturers, traditionally and sometimes contractually, engage in research, often individually or with a small team of graduates and often in a specialised field. Publications ensue and are regarded as an (even the) important criterion for promotion.

It is difficult to envisage a successful programme of environmental education at university level with no research base. That is not to say that all lecturers must research any more than all researchers must lecture. The special features of the environmental/professional subject area are the need for teamwork and the relationship between research and consultancy.

Environmental problems ramify extensively and many of them require a pluridisciplinary, perhaps an interdisciplinary, team to tackle them. Difficulties in achieving this arise from individual attitudes (attempts to protect and reinforce ones own disciplines, lack of interdisciplinary training among lecturing staff), institutional organisation (academically and physically separated departments) and the blinkered attitude of some funding organisations. The scientific general gap ensures that there are no senior environmental scientists as such. Gradually the new generation of interdisciplinary environmental scientists and environmentally oriented professionals will replace the existing lecturing staff and the existing research grant committees and two of the constraints will be lifted. Institutional organisation is difficult but not impossible to reform in existing institutions. More progress can be made in newer institutions.

In Michigan Engineering a number of the group projects have developed in doctoral thesis topics or fully fledged research efforts supported by the National Science Foundation. At Columbia there are two highly specific research laboratories mentioned in the case-study, the Trace Metals Research Laboratory and the Community Noise Research Laboratory, and certainly research with such clearly defined aims is easier to organise, staff and support. The interdependence of research and teaching need not be very high in such a case. The problem is to create the broader pluri-disciplinary research programmes that environmental sciences would seem to require.

On the second point, research and consultancy, it is clear that there is a complete gradation from pure research through applied research to consultancy. Precise definitions are difficult but most people recognise the extreme situations. There is a time difference also in the sense that a good deal of research is based on anticipating the consultancy problems of the future and laying the scientific basis for their solution. An individual lecturer, allocating his time between research and consultancy, may be pulled both ways. Research may lead to publication and thus promotion whereas consultancy may lead to extra money now. Senior staff, with no further need for promotion, may take on too much consultancy to the detriment of their university teaching and administration duties, and this is a particular hazard among professionals. However, consultancy, as suggested above, can provide material for group projects. It is common in the U.S. system for students to be working part-time as research assistants to earn money to pursue their course of studies so that they gain research orientation indirectly in this way. The feedback from either research or consultancy into teaching is difficult to determine.In Britain the importance of research for teaching certainly has sacred cow status but in the U.S. it seems to be recognised, more realistically, that some faculty members do mainly research and some do mainly teaching.

The Rothschild Report in Britain has recommended that scientific research should be organised to a much greater extent on the customer-contractor basis. Consultancy, of course, is so organised anyway but it may attract funding which can be used to help research or teaching (e.g. in Britain an externally funded research fellow is usually permitted or encouraged to do up to six hours a week of teaching).

CONTINUING AND RECURRENT EDUCATION

Increasingly professionals require some element of continuing education to keep up to date with changing technology and changing social and environmental conditions. It is clear that this continuing education should contain a good element of the new environmental awareness and knowledge. Equally teachers or lecturers in environmental topics will need refresher courses from time to time.

CONCLUSIONS

The group discussion on this topic is reported elsewhere in this volume (p. 30). However, this final section seeks to relate these group discussions to the case studies and the present analysis by identifying areas of general agreement and areas requiring more discussion.

There was general agreement that professionals, because of their advisory and executive responsibilities, are a particularly important target for environmental education. This education might occur at a number of levels ; all professionals would require some general environmental orientation and knowledge of environmental problems. Those whose activities had direct relevance for the environment (which is true of most professionals) should have a relatively deep understanding of the environmental impact of their own profession and how their professional expertise can be used to minimise undesirable effects. Finally some professionals would be very directly involved in environmental control and might be termed Environmental Engineers ; they would obviously need a fuller understanding of the environmental systems they were dealing with.

There was also general agreement that the most effective method of imparting truly interdisciplinary environmental education was by the problem oriented real-life case study referred to above. More information is needed about implementation, examples of sucessful and unsuccessful case studies, etc.

Recurrent education was one theme of discussion during the Conference (1). Its vital importance was recognised partly because professionals already in practice need to catch up on their

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1) See."Recurrent Education in Environmental Science and Management" by J. Bossanyi (CERI/HE/CP/74.10).See Annex 2.

environmental education but also because initial education and experience on the job will never again be enough to last a professional through his career. Again the concept is relatively new and much more information is needed on techniques.

There was less consensus about the optimal make-up of the teaching team. Its members can include :

a) full-time academics, with or without a professional qualification, often carrying out applied research or consultancy ;
b) part-time academics, perhaps carrying out a large consultancy work ;
c) full-time active professionals, either discussing their work on the ground or coming into the university to give an occasional lecture or seminar.

An active team leader is needed to prepare a coherent interdisciplinary programme, to co-ordinate everyone involved in the teaching, to encourage consistent terminology and units. The commitment of time, effort and administrative back-up needed for this co-ordination must not be overlooked.

Finally, international co-operation was generally commended but it proved more difficult to define what forms it should take. International organisations with clear environmental responsibilities (e.g. FAO, WHO, WMO, UNESCO, UNEP, SCOPE) are already achieving it. The present conference was the result of an initiative by another international organisation (OECD) with broader responsibilities, including educational and environmental ones. Sharing of ideas and information, interchange of personnel and the organisation of conferences and training courses are usually wholly beneficial providing the time and money commitment is not excessive.

Part Three

ENVIRONMENTAL RESEARCH

Chapter 1

PRINCIPLES FUNDAMENTAL TO THE INSTITUTION OF ENVIRONMENTAL RESEARCH AND PROPOSALS FOR ITS ORGANISATION

by

V. Labeyrie, Director of the Centre d'Etudes Supérieures
de l'Aménagement, University of Tours, France

1. Ecology is the study of the economics of nature (Haeckel).

The ecological approach calls for the study of ecosystems, i.e. spatial entities, as functional systems.

Cohesion in each ecosystem is provided by the stability of its internal bonds.

Each spatial entity comprises the four compartments of the ecosphere : lithosphere, hydrosphere, atmosphere and biosphere.

Exchanges of energy and material take place at the interfaces of the four compartments in accordance with their physical characteristics.

Every ecosystem is an open system, exchanging material and energy with neighbouring ecosystems, particularly through the most mobile compartments.

The ecosphere itself is an open energy system.

2. The circulation of energy and material within an ecosystem calls for the study of relationships between compartments at their interfaces.

No ecological study can be limited to one particular compartment of an ecosystem or of the ecosphere. Any ecological study extends beyond research into processes specific to some given compartment.

Ecology can be considered no more a branch of biology than of geology.

The techniques of ecology are adopted from its disciplines that have for long been dealing with processes in each compartment ; suitable methods must be worked out for studying exchanges at the interfaces.

Any ecological study must therefore be multidisciplinary.

In ecological laboratories, research workers with different backgrounds cooperate on some problem relating to the operation of a given ecosystem.

3. The input of energy into the ecosphere varies periodically as determined by the earth's motion.

The amount of energy received varies in time and space according to the geographical situation of the ecosystems.

At the same latitude, local differences in climate occur, depending on the physical characteristics of the various compartments and the heterogeneity of the earth's surface.

The chemical energy converted from light in the photosynthesis process is stored, thus resulting in continuous activity of the biosphere.

An ecosystem reaches energy balance when all the accumulated chemical energy is utilised by the action of living organisms. The processes of respiration and photosynthesis in the ecosystem are then in equilibrium and the O_2 and CO_2 balances are zero.

In an ecosystem with an energy imbalance, particularly when not all the ecological slots are filled, respiration may be less than photosynthesis ; this leads to an accumulation of organic matter.

The activity of living organisms must match the periodicity of energy. Since energy depends on latitude, any change in latitude produces a mismatch and leads to selection.

The interactions between the earth's morphology and the physical characteristics of compartments produce deviations from the theoretical values of many periodic physical parameters.

The lithosphere's own activity, variations in the energy inflow, interactions between these factors and the circulation of material in the different compartments can lead to disastrous events which are completely aperiodic. Any new element introduced into an ecosystem can act as a calamitous factor.

Possibilities of selection are limited by any departure from theoretical periodic values. Survival is made possible only by the variety of individual responses and the diversity of possible responses within populations of each type of organism.

Selection in a given ecosystem is both controlled and variable.

The larger a population and the richer its genetic make-up the greater the possibilities for phenotype diversification and the higher the probability of survival.

No selection process can be oriented by phenomena of a calamitous nature which upset the population of organisms and disrupt the qualitative and quantitative evolution of the populations.

All ecosystems are evolutive, and none are stationary. Every ecosystem is the product of on-going evolution.

It is impossible to preserve nature unchanged, and the objective of nature protection cannot be to maintain a status quo.

Human activities should be organised in such a way that evolution can continue without any loss by ecosystems of biological capital and of genetic capital by populations.

The study of the evolution of the populations in each ecosystem calls for determination of their biological and genetic capital.

Any simplification of an ecosystem implies that both these forms of capital be depleted.

It is essential to maintain reserves of biological and genetic capital. This can be done only in ecological conditions corresponding to each type of ecosystem.

Only by simulating the operation of ecosystems can the evolution of these capitals be studied experimentally.

4. Since the ecosphere and ecosystems are open energy systems, the periodic introduction of energy prevents entropy and allows the systems to operate permanently.

The energy balance of each of these systems depends on the ratio between the usable incident energy and the degraded energy released.

Any alteration in this ratio changes energy balance.

The release of potential energy contributes to this change.

The continuous nature of human activities requires that the energy balance of the ecosphere be respected. The tapping and use of free energy make such continuous activity possible without reducing the amount of usable energy.

The human economy should be redirected towards the use of sources of free energy in the ecosphere rather than sources of potential energy.

Research should deal with methods of using the different forms of free energy.

All parts of the world possess sources of free energy in one form or another. Development of the different usable sources is one prerequisite for balanced development in the different countries and their economic salvation.

5. The organic molecules of fossil fuels originate from a process of synthesis during which there was an input of energy ; they are the raw materials which enable more complex synthesis to take place.

Materials circulate between the compartments of each ecosystem and between ecosystems. Although displaced, the materials are not consumed. Materials are inexhaustible; only organic matter can be degraded and must be renewed.

Apart from uranium and thorium, raw materials are not exhausted. Displacement takes place, from ecosystem to ecosystem, whether or not a change of compartment occurs. Urban development increases the displacement.

When the human economy is based on the production of goods enabling capital to be invested in means of production, then the industrial materials circuit is broken.

After processing and use, raw materials are converted into wastes. The industrial process transfers matter from the raw materials compartment to the wastes compartment.

This one-way traffic, by breaking the circuit in which materials are circulated contradicts the permanent nature of economic activity. Permanence means reinserting goods into the production process after they have been used. It is independent of growth rate. Zero growth is a false ecological problem.

The one-way traffic situation is made worse by the technical obsolescence of goods and production facilities. It is artificially aggravated by the obsolescence deliberately built into goods which is linked to the reduction, in the production process, of the relative magnitude of variable capital generating capital gains.

If artificial obsolescence is eliminated, human labour can be freed for other purposes and the energy used to provide society with a given service can be reduced.

Recycling goods into the production process after use calls for redistribution of the manpower now concentrated upstream of the goods. This requires that the means of production and the goods be so designed that they can be re-introduced after use into the production process.

The training of engineers should be revised in the light of this double requirement, i.e. later recycling and longer useful life, without reducing the service given by plant and products.

The economic obstacles standing in the way of these ecological requirements should be removed. Any economic system will henceforth be assessed in terms of its capacity to achieve these objectives.

6. Man has gradually colonised all ecosystems. No natural ecosystem is safe from man's intrusion. As a result of the introduction of DDT and radioactive strontium into the atmosphere compartment, all ecosystems are contaminated.

The scientific and technological revolution has increased man's capacity for intervention and has shown how inadequate his methods are.

The consequences of human activity are spread through time and space. Any action in terms of sectoral and short-term objectives conflicts with the economics of nature.

The sectoral and short-term pattern of economic activities stems from the production ratios which were developed during the industrial revolution. As a result, men have been trained according to a sectoral bias in order that industrial processes might be controlled, with no regard for their ecological background.

An essential part of any solution to the environmental crisis is to renounce an economic system ultimately designed for sectoral, short-term profits. A change in growth rate cannot obviate this necessity.

If the crisis is to be resolved, there is no alternative but to reform training systems designed with these objectives in mind.

Research should be intensified in order that the ecological consequences of production processes can be ascertained and the content and form of university courses so designed that men can be trained to grasp the nature and extent of these problems.

7. Each population is a link in the chain of energy and materials flowing in an ecosystem. There is no such thing as an isolated population.

The dynamics of a population depends on the dynamics of the system. The interactions between trophic chains tend to damp fluctuations in populations.

The more complex an ecosystem, the more varied the slots and the more limited any quantitative changes in population.

The more simplified an ecosystem, the rarer the stabilising factors and the greater explosions or regressions of populations become. In simplifying ecosystems by restricting them to those species that are useful to him, man substantially increases their fragility. He must act deliberately in order to maintain the level of useful populations.

This law of ecosystems applies to human activities. The more varied the industrial complex of a country or region, the less sensitive it is to market fluctuations or to technological upheavals.

8. In the course of time, man has transformed the vast majority of ecosystems. Relationships between man and nature have taken on various aspects according to how the different cultures of mankind have evolved.

It is impossible to alter man's intervention in these different ecosystems without taking historical patterns into account.

Any change in the human economy must be made in the light of requirements of the natural economy and of the relationships between man and nature which exist in a given ecosystem.

Managers of the human economy should be taught the natural laws governing the operation of ecosystems and trained in the human sciences which determine types of relationships between men as well as between man and nature.

These relationships are evolutive in character. By studying the evolution of the interactions between society, science and nature, the ideological aspects of the environmental crisis can then be analysed.

It is no longer possible to separate the economics of human activities from the economics of nature. Any change introduced means inserting the human economy into the natural economy. The system of training economists to deal with economic activities while neglecting natural economics should be replaced.

9. The division of human labour has led to the formation of towns, and this has been made possible by developing means of communication.

Growing urbanisation geopardizes the circulation of materials by depriving certain ecosystems of essential elements and by stifling others by means of these same elements.

As a result of the development of means of communication, the appearance of less ponderous materials, the diversification of energy sources and the reduced dependence on conventional energy sources and traditional materials, a balanced redistribution of human activities in space can begin.

New means of communication can contribute to limiting man's movements.

Man can begin distributing his activities in the light of ecological constraints and his need for fulfillment.

Town planning and development activities should be regarded no longer in terms of a narrow, outmoded economic rationale but in the light of ecological constraints and man's needs.

10. The speedier growth of knowledge and technology means that structures will have to be more adaptable.

All development activities must be planned so as to less jeopardise the future. They must be functional but capable of alteration.

All civil engineering works should be designed in the light of their speedier technological obsolescence, so as to less jeopardise any later alterations and re-use.

It is therefore necessary that the whole strategy of civil engineering be revised.

Legal and administrative structures reflect a given stage in the evolution of society. The greater speed of scientific and technological revolution is changing living conditions.

As knowledge and technology expand, and as the technical and practical revolution proceeds, legal and administrative structures rapidly impose constraints and hinder the development of society.

In their present, precise state, they must increasingly often be changed. At the same time, the norms governing relationships between man and nature rapidly become outdated.

If legislation is not continually to fall behind events, detailed legal and administrative relationships cannot be established. Legislation should increasingly become a framework for general principles so that flexible application can take place as society develops.

11. The expansion of knowledge pushes back the boundaries of understanding in increasingly varied fields and leads to the interdependence of areas of knowledge.

Research cannot be channelled solely into sectors where some technological advantage can be foreseen. The increased interdependence of disciplines instead requires that knowledge as a whole be developed, since some neglected sector increasingly threatens to jeopardise the whole.

All human activities must fit into open systems ranging from the ecosphere to individual organisms themselves. It is no longer possible to disregard the position of any of these systems, whether for purposes of study or action. The study of complex systems is becoming a decisive factor.

The aim of training should be to produce specialists capable of study ing one particular aspect in depth as well as generalists capable of studying the operation of a particular system.

Any specialists perceived as a generalist by someone studying a more limited process, and any generalist is perceived as a specialist by someone studying a system of a higher order.

Technologies are becoming obsolete at an increasing rate. It is impossible to teach techniques that will endure throughout professional life.

It is becoming essential to learn how to learn. Education can no longer be limited to the pre-professional phase of life.

The objective of training should be to acquire an understanding of principles and methods rather than to learn specific techniques which are immediately out of date. Montaigne's goal of "a well-trained brain rather than a well-filled brain" is more than ever desirable.

Young people are increasingly conversant with phenomena which previous generations knew nothing about. The hierarchy of age no longer corresponds to the hierarchy of knowledge. Personal experience acquired with age is no longer the prime source of understanding. Imparted social awareness is becoming increasingly important.

Youth thus increasingly rejects any authority or hierarchy based exclusively on age. Lacking opportunities to renew their knowledge, the oldest generations can no longer keep up with social change ; they are left behind owing to circumstances they are unable to understand.

It is thus a social as well as an economic necessity to enable man to readjust to circumstances by continuously updating his knowledge.

The timetable of every adult should be so organised that he can spend an increasing proportion of time adding to his knowledge.

The technological upheavals which are transforming entire sectors of the economy call for substantial occupational changes, which are feasible only if the knowledge of all concerned is as wide as possible.

12. The environmental crisis, which parallels the scientific revolution, is affecting all areas of human activity.

It is therefore unthinkable that environmental research facilities should restrict their activities to some specific field. The orientation of all current research should be revised so that the problems of the changing ecosphere and man-made ecosystems can be dealt with.

No exhaustive list of the sectors affected can be drawn up. Every one should be reviewed, with due regard for their various components, which must all be known if some given system is to be understood.

Stressing the need to develop research with the environment in mind in no way means that a new discipline must be set up. What is needed is to re-examine strategies which have been adopted for expanding knowledge and promoting human action.

The accumulated lag in knowledge regarding the growth of complex systems, particularly the ecosphere and natural man-made ecosystems calls for a strengthening of man's research potential, not a pause in such efforts.

Since ecological problems are linked to natural constraints dependent on the operation of ecosystems, research should deal with systems regardless of national boundaries. Scientific cooperation is a sine qua non.

As the strategy for action in man-made ecosystems must take history into consideration, it should be based on research into both the natural and human sciences. Strategies cannot be transposed from one man-made ecosystem to another.

Any research concerning the ecosphere and ecosystems calls for international co-ordination to determine what is common and linked to natural laws, and what is contingent and linked to the social and economic development of some given society.

The magnitude of the scientific effort that needs urgently to be undertaken is such that any wastage of men and resources must be eliminated. It is essential that the men and resources still engaged in developing the means of destruction be channelled in other directions.

Chapter 2

THE SPECIAL CHARACTER OF ENVIRONMENTAL RESEARCH AND PROPOSALS FOR ITS ORGANISATION

by

J.M. Abillon, Department of Environment,
University of Paris VII, France

POSITION OF THE PROBLEM

A. The Environmental Crisis

The environmental crisis must be blamed on the affluent societies, whose present ills are much like those of people who have eaten too much. This would not be so bad (obesity can be cured by strict dieting) were it not for the fact that people who do not eat enough also suffer.

It may safely be claimed that the currently unbalanced state of the universe - pollution, the destruction of biosystems, the population explosion and the increasing lag of the underdeveloped countries - is a direct or an indirect consequence of the growing demand for and squandering of world resources.

The reason for this demand and wastefulness is the poor use made of the advances resulting from the scientific and technical revolution, which have vastly added to all or at least part of humanity's capacity for action. On this score, J. Platt (1) estimates as follows : "During the last century we multiplied our communication speed by a factor of the order of 10^7, our travelling speed by 10^2, our recording speed by 10^6, our energy resources by 10^3 and our fire power by 10^6...".

Energy has therefore been and is still being used in steadily increasing quantities. In the United States, this increase yearly amounted to 2.8 per cent from 1947 to 1965, but rose to 5 per cent from 1965 to 1969. Between 1905 and 1938, more metals were used than had ever been before this period. According to H. Brown (2), the United States economy requires that 25 tons of material be extracted per capita each year.

According to the systems dynamics group at M.I.T. (3),by assuming a rate of use stabilised at present values (while the population is growing exponentially and average individual consumption increases annually), based on resources five times greater than known reserves aluminium resources will be exhausted in 55 years, copper in 48 years, lead in 64, mercury in 41, petroleum in 50, etc.

This, of course, applies to non-renewable resources. Where renewable resources are concerned, during the past year costs have risen at a staggering rate. According to a recent OECD study (4) of price trends on international markets, wheat prices have trebled, maize doubled, soya doubled or trebled, cotton doubled and wool increased nearly fourfold between 1972 and the end of 1973. Part of the process can be accounted for by the fact that "... stocks - especially stocks of wheat and soya beans - declined progressively. The decline was even more pronounced in relation to world trade. Thus almost without realising it, the world moved into a situation of insecurity regarding supplies, at the mercy of unforeseen contingencies like those which were to occur in 1972/73" (such as the poor grain harvests in the USSR and China, and the substantial drop in Peruvian fishmeal production).

A natural corollary of the greater use of energy needed to process resources is heavier pollution. The Meadows report (5) thus points out : "The process of economic development is in effect the process of utilizing more energy to increase the productivity and efficiency of human labour. In fact, one of the best indications of the wealth of a human population is the amount of energy it consumes per person. Per capita energy consumption in the world is increasing at a rate of 1.3 per cent per year, which means a total increase, including population growth, of 3.4 per cent per year.

At present, about 97 per cent of mankind's industrial energy production comes from fossil fuels (coal, oil, and natural gas). When these fuels are burned, they release, among other substances, carbon dioxide (CO_2) into the atmosphere. Currently about 20 billion tons of CO_2 are being released from fossil fuel combustion each year.... The measured amount of CO_2 in the atmosphere is increasing exponentially, apparently at a rate of about 0.2 per cent per year. Only about one half of the CO_2 released from burning fossil fuels has actually appeared in the atmosphere - the other half has apparently been absorbed, mainly by the surface water of the oceans."

Even though the effects of such higher percentages of CO_2 in the atmosphere have yet to be more closely investigated, they already seem rather alarming. This is because our planet is an open thermodynamic system and constantly receives energy from the sun which is dissipated into space. The temperature of the earth's surface results from the energy balance between incident solar radiation and the infra-red rays which are emitted. Any change of relationship between dissipated radiation and incident rays directly affects climatic conditions.

It so happens that the CO_2 in the air and the cloud cover in the lower troposphere add to the "earth effect", by limiting the dissipation of infra-red rays. Hence the atmosphere tends to become warmer. E. Fedorov thus estimates that a 1 or 2 per cent rise in surface temperature can have considerable climatic effects and cause the polar ice to melt.

Economic activity moreover dissipates heat by releasing energy which has played no part in the energy balance of the ecosphere. Again, according to E. Fedorov's calculations, energy released by human activity amounts to some 0.01 or 0.02 per cent of incident solar energy. At the present rate of increase, in 50 or 60 years, the figure would be 1 to 2 per cent. P.F. Chapman (6) sets the threshold beyond which the ecosphere's energy balance would be destroyed at 5 per cent, a limit which in the Los Angeles area already extends over 10^6 hectares. In the opinion of S.M. Greenfield (7), by the year 2000 this threshold will have been exceeded in the eastern United States over a 90×10^6 ha area. On the strength of these data several documents, including the Meadows report, set an energy limit to the growth of human activities.

"Nuclear energy", put forward as a cure for all the difficulties stemming from the increased cost of oil, does not solve the problem of heat dissipation and "will produce yet another kind of pollutant - radioactive wastes. Since nuclear power now provides only an insignificant fraction of the energy used by man, the possible environmental impact of the wastes released by nuclear reactors can only be surmised" (3). We omit any reference to the effects on the human body of continued exposure to small doses of radioactivity, which have only begun to be studied.

For the record we may point to all other forms of pollution, amply described in the press. Yet these are but a foretaste of what the immoderate use of resources can lead to.

In the capitalistic system, the object of which is to generate profits by producing goods, materials used are transferred from the natural-resource compartment to the waste compartment. By following such a strategy sources are depleted while the earth inevitably becomes choked up with wastes.

The threatened exhaustion of major land sources is the reason which originally prompted a continued effort to improve the mining of scattered deposits, make use of the ocean bed or concentrate the salts dissolved in seawater. Regardless of any advances achieved, these can but postpone the final day of reckoning if the principle of the economic process is still to consist in transferring assets from the resources to the waste compartment.

As fixed assets increase, profits decrease with improvements in technology, with the result that a quicker rate of turnover is systematically sought by renewing goods at a faster pace. Hence the common practice is to reduce their use value by decreasing durability. Goods are purposely designed to last the shortest possible time. The mass media help to shape public opinion in causing fashions to change, thus promoting the rejection of goods which still have some use left in them. As early as 1822, Fourier (8) denounced the "system bent on bringing about the industrial disruption caused by changing fashions and on manufacturing shoddy fabrics and furnishings in order to double consumption and enable merchants to make money at the expense of real wealth".

At the time an increasing share of materials, including large quantities of scarce goods, is used in arms production, which rapidly become obsolete due to the part played by the scientific and technical revolution in the arms race. This type of waste, though very substantial, cannot accurately be evaluated since no exact figures are provided in official documents.

Human activity not only entails transfers from the resources compartment to the waste department, but consists in shifting any materials which are extracted, processed or used from one area to another. Waste is thus geographically displaced in relation to resources. During the utilisation process materials are transferred from the lithosphere to the hydrosphere and atmosphere, or from the hydrosphere to the atmosphere. Hence no mere geographical shift occurs but an ecological transfer from one compartment of the ecosphere to another. The scattering of materials into the hydrosphere is substantial, and even more rapid and widespread in the atmosphere. In the space of a few weeks the strontium 90 released by a nuclear explosion can thus travel round the world. A pesticide such as DDT can remain in the air several years and contaminate any part of the globe. The lead produced upon burning of premium motor spirit leaves sizable traces on the polar cap.

We mentioned that the Meadows report sets an energy limit to the growth of human activity. But this limit exists only insofar as the energy used comes from a potential source, i.e. from an energy source built up through geological time. If instead man makes use of free energy he does not change the balance and taps a source which is constantly being renewed, since the ecosphere, as we have said, is an open energy system.

All living populations are thus links in the chain transferring the chemical energy obtained from light energy by photosynthesis. Broadly speaking, the chemical energy of plants (primary producers) is used by primary consumers (herbivores), which become an energy source for secondary consumers (carnivores). Decomposers thereupon burn up most of the energy contained in the dead tissues consumed, and therefore can only exceptionally serve as an energy source for further links in the chain. Some recycling is however possible with extremely dense populations. Plans to obtain proteins from bacterial cultures as food for mammals come under this heading.

No animal population is hence able to live in isolation. Its size depends on that of its energy source (the lower trophic level which is used) and on how many consumers and decomposers make use of it in turn as a trophic source. Each population is both food and feeder, with the result that no change in population level can occur without balance being restored owing to the influence of the species with which it interacts. A certain stability of natural populations thereupon ensues, known as biological balance. This essential concept has often been ignored by "nature conservationists" who, in order to protect a particular species, have eliminated its predators. Such an approach has led to a population explosion of the protected species, whose numbers could no longer be kept down by predators, followed by a sudden drop through hunger or disease below the level the population would have reached in a balanced system.

Human populations managed to rid themselves of most of their own predators during the first few hundred years of their history. They have also recently become free of the decomposers (pathogens), which up to the last century still preyed upon them. Hence such populations are an "ecological cul-de-sac". This is because, while they continue to depend on the availability of food resources, they are no longer kept within bounds by consumers and decomposers. They will never be entirely freed from this constraint until man is able to create living matter through artificial photosynthesis.

Biologically, the outcome may be a population explosion of the human species far in excess of the one we are now witnessing. The reproductive behaviour of humans was however codified at a time when mankind was subjected to huge ecological pressures from decomposers and warfare. In the countries now considered developed, most religions and laws necessarily favoured a high birthrate, and lacking such a policy populations would have disappeared. For sociological reasons, however, these laws are no longer suited to the new era in the history of such populations. In the so-called underdeveloped countries the pattern has been very different. The remarkable degree of demographic balance achieved by many of these populations was destroyed, as will later be seen, by the largely disrupting influence, whether conscious or not, of colonial systems nor is the eradication of disease among these groups the only factor responsible for the present population explosion.

The important fact to note is that the human species has usually adjusted and continues to adjust its reproductive habits to existing production means and ratios. This adjustment is the result of a long evolutionary process and in some cases is reflected in extremely specific sociological laws. "Before the 'developed' countries intervened, the rural population in traditional African systems had reached a stage known in ecological terms as a 'climax', with the control systems adapted to such communities, which were relatively stable from a demographic standpoint. The consensus has nearly always been that the lower death rate achieved through the prevention of disease, including malaria, destroyed this balance. In such areas as the highlands of Angola, however, population growth was not the result of health assistance, but rather seems due to interference with the social systems promoting birth control ...."

Hence it is invariably difficult to ascribe the lower death rate to some specific action, as in Ceylon where malaria control has been regarded as the decisive factor. Yet in areas free of malaria and where no steps had been taken, the decrease in the death rate has been exactly the same. In most cases, therefore, the system of population control peculiar to extremely rigid cultural groups may be said to have been tampered with. In many African cultures births used to be carefully controlled by marriage practices, abortion, initiation rites and other methods. This system of control was greatly weakened by the disappearance of such rites, changes in marriageable ages, etc. Since anyone was free to procreate, it is small wonder that the birthrate should have increased. Nearly every so-called "primitive" population has its own social methods of regulating births. It is not merely by introducing contraceptive pills, uterine devices or sterilisation that births can be controlled, but when the need is also recognised by the community itself (9). One telling example among others is the failure of India's aggressive birth-control policy.

Demographic conditions hence vary in terms of production ratios and the technological and cultural level achieved by the social strata in different countries. There is not, nor can there ever be, an average world rate of population growth.

Such, in very brief terms, are the four essential marks of the present environmental crisis : the exhaustion of natural resources, pollution, loss of energy balance and the population explosion.

B. Economics and Ecology

The astonishment evinced in economic and political circles, particularly in France, upon publication of the Meadows report for the Club of Rome and the Mansholt report for the European Communities shows how little ecological concepts affect the thinking of the economic and political leadership. While these reports fail to take certain basic ecological data into account and are guilty of fundamental methodological errors, they do succeed in impressing the gravity of the problem upon a public generally less responsive to the arguments of ecologists than to the coolly complacent attitude of someone like H. Kahn, whose scenarios bank on the steady growth of population and of gross national product per capita.

Yet a few economists have earlier underlined the extraordinary degree of conflict between the nature of the problems and the economic methods used. Thus A.W. Eipper (10) considers that "conventional economic criteria are at best inadequate and at worst disastrous when they are used as the sole basis for decisions regarding natural resources".

It is surprising to note that the writings of K.E. Boulding (11), pointing as early as 1964 to the need for an economic policy based on an understanding of the processes that govern the ecosphere, should have had such a limited impact. In 1966 he wrote that "most economists have been unable to grasp the final consequences of the transition from a limitless earth to a limited earth". He called their economics "cowboy economics", the cowboy symbolising "limitless plains associated with a carefree, rough, romantic and violent behaviour characterising open societies". Such analyses do not however appear to have prompted the political and economic leaders of western Europe to ask themselves any questions. Thus W. Beckerman (12), an economist who is a member of the United Kingdom's Royal Commission on Environmental Pollution, wrote in a 1972 issue of The OECD Observer as follows : "Contrary to a widely held belief to the effect that growing awareness of the environmental problem demonstrates the inadequacy of traditional economic theory and the need for some sort of 'revolutionary' new approach to economics, almost all the major features of the environmental problem can be greatly clarified in the light of existing economic theory".

While, as pointed out by Marston Bates (13), ecology and economics have common roots, they are generally unrelated, taught in quite separate university departments and are dealt with by categories of research staff who have nothing to do with each other.

This is largely due to the ambiguity, particularly in France, of ecology's area of investigation. Of Haeckel's 1869 definition none but the most restrictive aspects of relations between living beings and their environment have often been retained. Owing to this narrow base ecology is regarded as a branch of biology, and some people still even speak of animal ecology and plant ecology. On this account they depart from the key aspect of Kaeckel's definition, which is that ecology is "knowledge of the economics of nature". Haeckel explained his position as follows : "The science of ecology, often improperly considered as biology in a narrow sense, has long constituted the leading element of what is commonly regarded as natural history".

Since the purpose of economics as a scientific discipline is to organise human activities, the problem is whether these can be organised without any knowledge of nature's economic laws. Historically, during the industrial revolution economic activities were organised by sectors and led to the creation of specialised schools of higher learning in order that specific economic goals might be met. Such training in terms of specific objectives prompted specialists to neglect the environmental side-effects and to look upon the environment as no single entity. Moreover, the sectoral development of activities, by being based on the production of goods in some particular branch, isolated production from other processes. The result was a sharp division of the natural sciences from the social sciences.

With the headlong growth of man's capacity for action during the scientific and technical revolution, the inherent defects of such a strategy were bound to erupt. The environmental crisis is the form this has taken. It would hence be wrong to claim that the scientific and technical revolution is what caused the crisis.

Since man is a part of nature and uses it to his own advantage, human activities cannot be organised unless the laws of nature are correctly understood. On this account the ecosphere, an aggregate made up of our planet and its gaseous layer the atmosphere, must be studied as a system whose laws of operation are known, including those governing the circulation of energy and matter. This entity can moreover be divided into subaggregates, i.e. into ecosystems or biogeocenoses or spatial units forming open subsystems which according to L. Von Bertalauffy's definition may be in a stationary state and within which most energy and matter circulates. Such ecosystems should be studied as autonomous, active, open cyclical systems harbouring living organisms, including man.

From the standpoint of ecology, spatial units must therefore be regarded as complex systems and studied from that angle. P. Shepard (14) thus rightly points out that ecology cannot be studied as such nor defined in terms of some particular technology. Hence, even though many ecologists come from different branches of biology, increasing numbers of physicists and chemists, for example, now also share in finding out how these systems work.

Unfortunately, although ecology has already made real progress and quantitative ecology has produced a number of laws regarding the operation of natural systems, the study of these must still be considered to be in the incipient stage. This situation is due to the traditional fragmentation of such systems, which are approached by artificially separating their various components on the strength of positivistic and reductionistic concepts ; for this reason the dialectic aspect of nature is entirely passed over, the premise being that the study of some higher system cannot be undertaken until enough is learned about others which belong to a lower order. According to these notions, in order to ascertain the properties of an aggregate it is enough to add the properties of sub-aggregates together.

The delayed use of ecological data for organising and distributing human activities must therefore be largely attributed to the lagging knowledge of how natural systems and the economics of nature work, and to the lack of any general systems theory required for such an understanding. Under these circumstances, the curbing of fundamental research, a step advocated by several industrialised countries, strikes us as a criminal act from the standpoint of man's future fate. In the United States research investment now tends to favour economics at the expense of biology and ecology, the argument being that economics, an older art long used in system manipulation, is therefore better suited to short-term forecasts. Such forecasts are however invariably directed towards objectives which, as we shall see, well deserve to be challenged. The present inability of economists and policy-makers by themselves to plan measures which will be followed and respected longer than two or three years shows the frailty of such provisions. In fact "the new frontiers of science lie", as pointed out by H. Brooks (15), "in the exploration and analysis of complex systems such as the ecosystems". To persist in delaying such studies means that errors will be perpetuated, nature further degraded, and the continuity of human activities jeopardized.

Until the lag can be made up, it must meanwhile be determined whether humankind is really confronted with the dilemma of pollution versus poverty, or whether some other policy for organising human activities can be given effect. This is all the more necessary as the only choice offered developing (or under-developed ?) countries threatened with malnutrition is the alternative mentioned above.

C. Growth or Development ?

Even the most superficial analysis of regional projects, so-called "development" planning and policy options clearly shows that the primary concern of authorities is to achieve a rate of economic growth which will benefit some favoured sector of the economy if not some highly privileged fraction of the population.

Growth and development are in fact quite different concepts, and their objectives may well conflict. Development indeed calls for growth, yet growth can be and often is achieved while development declines. Economists and policy-makers have unfortunately adopted the word development in an erroneous sense. To define growth and development, the first term simply means an increase in size (in production rates), while the second denotes transition through increasingly complex stages. These definitions apply with equal force to natural biological and human systems.

Under these conditions a corollary of growth may very easily be underdevelopment, such as found in the operation of natural ecosystems, whose fruits are removed so that ancillary systems can be developed. Through such action ecosystems are prevented from reaching maturity, i.e. an advanced stage of development. They can only stagnate in a state of immaturity and permanent imbalance. The ancillary systems which benefit, when of a human kind, may either be an urban system (preventing a rural system from producing), a colonial power (basing its growth on the colonised country's output), or a highly commercialised or industrialised power (increasing its hegemony with the help of the raw materials and cheap manpower, whether imported or not, provided by underdeveloped countries).

To take only the case of underdeveloped sectors, development must not consist in simplifying and eliminating the controls regulating these areas, unless the aim is to maintain them in an immature state and so deprive them of maximum output.

At this stage of analysis, two fundamental questions arise.

In the first place, is sheer growth compatible with development ? The answer is that not only are they compatible, but that growth is also a requisite for achieving successive stages of development. To take an example in third-world countries, the greater agricultural opportunities provided as a result of the spontaneous, largely effortless introduction of new crops has considerably promoted the development of African farm communities, which moreover goes to show that they were not closed societies. But when the rural sector, at whose expense urban areas are developed, shows any signs of resistance this attitude is qualified as routine inertia on the part of rural communities and is a source of marked irritation for economists who vainly strive to change what they consider to be a closed society. What this really means is that they have been unsuccessful in exploiting the sector quite as much as they would like, or in integrating populations more interested in quality of life into accepted patterns of international trade or buying and selling structures. Yet such populations are perfectly amenable to change provided it is to their advantage, by adapting growth to new forms of development. This in fact is what has happened in many parts of Africa, where rural communities have readily accepted new types of crop imported from America, such as manioc, groundnuts, beans, cacao, maize, cotton and the potato.

If growth is then a necessary factor, is the maximum exploitation of such growth and the intensive trading of products compatible with development ? From an ecological standpoint the answer is no,since the productive sector then has no chance to rebuild itself during latter, more advanced stages. We have already said that drawing upon such growth rather promotes development of the urban sector or some sector outside the producer country. It may hence be claimed that the only reason why the so-called developed countries have been able to grow and develop is because they wrongly availed themselves of opportunities which other countries no longer have access to. Ipso facto, the other countries cannot retaliate, since the haves would then merely change places with the have-nots.

Hence it will most likely be impossible for the developed countries to continue along the same lines, mainly because the other countries will be less and less compliant. Another reason is the disaster which would ensue in regard to the recycling and depletion of natural resources, pollution, etc.

In concluding this brief analysis, which will be expanded later in this paper, it must be pointed out that development does not consist in destroying conditions such as to prevent growth by building up a control system and human system which are totally in conflict with nature because they are utterly removed from natural systems. What development really implies is an understanding of how the man-made system taken as a whole can be made to function in the best interests of mankind.

Unfortunately the chances are that anything ecologists, sociologists, or even well-intentioned politicians could do to the course of developed countries would be utterly fruitless. Matters have now reached a stage where some events can perhaps be postponed but hardly prevented. Otherwise it would be the first time any civilisation engaged in a sheer process of accumulation by draining some external sector failed to collapse like others before it (16).

THE OBJECTIVES OF ENVIRONMENTAL RESEARCH

Having once briefly reviewed the reasons for the present environmental crisis and shown that it is primarily due to the fact that decision-makers (politicians and economists) confuse growth with development, a process aggravated by the fragmented approach to problems, we are now in a position to define what may logically be described as environmental research.

Such research can, of course, be defined only in terms of a general development policy. If the essential objectives guaranteeing a satisfactory quality of life for mankind were lost sight of, an extremely technocratic approach to problems would rapidly result. To mention but a single case, that of pollution, the current practice is to try and remedy the effects without tackling the core of the problem, which is to cure the root of the evil. The paradoxical situation which has consequently arisen is that yet further energy is consumed to reduce the effects of poor energy utilisation. Anti-pollution devices are thus installed in motor vehicles, whereas a sounder transport policy (17) would largely eliminate pollution by automobile engines and prevent oil products from being wasted.

What are, then, the essential objectives that will enable man's quality of life to be improved ? These might be defined as follows :

- the right to existence, the right to health and the right to culture, including the preservation of local, ethnic cultures ;
- the right to shelter and to the fair distribution of resources ;
- the right to free time and to recreation.

Implicit in the right to existence and to health is another right, that of freedom from hunger. While to us, who are nationals of developed countries and are more than amply supplied, this may seem an elementary proposition, quite the opposite is true of third-world countries. Here, with minor exceptions, the statistics show that food production per capita has declined in spite of all efforts to increase or intensify agriculture.

Thus the main objective in most third-world countries is not to achieve a maximum yield per acre in order to solve the vital problem of feeding the population. It would be meaningless to undertake research so that one acre could be made to yield two or three times as much as it does now, or so that varieties capable of achieving these levels could be introduced, since there are no farmers able to apply these methods or grow such varieties. Moreover, in most cases the solutions proposed consist in intensifying permanent farming, while all the research so far conducted on tropical ecology has yet to show whether the soil in these regions can in fact be permanently farmed under present conditions, or whether shifting cultivation, the usual practice, can be replaced by a more profitable stable kind undertaken by the local population.

In the case of traditional third-world farming populations, however, as clearly illustrated by African examples, security is the prime consideration, and the great diversity of some of them, left largely untouched by the colonial system, is conducive to the sort of stability guaranteeing such security. But security can never be achieved by oversimplified systems aiming at maximum productivity, since these are invariably unstable and have no built-in controls. The recent disaster in the Sahel region, where poor climatic conditions (that because of their cyclical character could easily have been earlier foreseen) were the catalysing agent leading to the rapid degradation of an unduly simplified farming system, is an example which well deserves to be considered by economists and agricultural experts alike. One of the objectives of a genuine "green revolution" in third-world countries should be the diversification of activities as well as rational integration with, and careful handling of, the environment ; while natural systems of control, of which man is necessarily a part, should as far as possible be preserved.

The problem of health is largely one of sociopsychological and somatic imbalance. Mental disease is increasing in urban centres, which are no longer regulated by sociological controls. Although western medicine has made enormous strides in eradicating disease, so far it has only offered remedies for effects rather than causes. The problem in underdeveloped countries is altogether different, in that health research should begin with nutrition, which is related to the complexity of rural cultures. The same process occurs in any plant ecosystem, which becomes infested with parasites if its mineral diet is inadequate. A development policy should therefore allow the cultures of such social groups to evolve in their own way, to maintain and even strengthen the controls inherent in the system and prevent them from being stamped out by some western culture or that of some dominant group.

The most critical problem is clearly the fair distribution of resources, since almost all growth patterns increasingly tend to create inequity. This is especially prevalent as regards appropriation of the goods produced under the system of some country or class of society (e.g. rural or "factory workers"). It is the result of a system where the majority is despoiled for the benefit of a small minority. The same pattern occurs in nature, in which mature (developed) ecosystems sometimes function at the expense of immature (underdeveloped) ecosystems.

The last problem is that of free time and recreation. While the ultimate purpose of progress would seem to be freedom from work constraint, it is easy enough to see that progress in many instances has actually consisted in creating additional tasks as a means of increasing wealth, and still does. The hidden or chronic unemployment found in industrialised countries is thus recognised by economists as something which should be exploited only as a means for promoting further growth. Actually such free time (or lack of work) should be regarded as a perfectly normal situation, and such "lost" time is often used, or should be, for essential purposes of social control. One works in order to live instead of the other way round, regardless of what the puritan ethic may say.

It now seems clear that environmental research cannot be undertaken with a view to achieving the present goals of growth policy. Other courses must be plotted, with the object of integrating man more closely with his environment, and so enabling him to achieve a better balance both with nature and his fellow creatures. We must firmly resolve to stem the tide of degradation and permanent disruption now rising at every level and engulfing all countries. This calls for courage and political awareness on the part of all communities confronted with these problems. Yet this will not be enough - it is vital for the human species that a far-reaching policy be promptly devised for undertaking fundamental and applied research into natural and man-made ecosystems.

WHAT TYPE OF RESEARCH IS NEEDED ?

Since man is a component part of the environment and uses it to his own advantage, just as all other living creatures on a smaller scale, environmental research must be deliberately based on the study of more or less complex man-made systems. We shall therefore begin by eliminating research dealing with some single discipline, single factor or partial aspect, since an unduly fragmented approach towards environmental problems would result.

We have already explained what we mean by "ecosystem" - it is a term that should not be interpreted in the strict biological sense. In studying the operation of ecosystems, therefore, an interdisciplinary approach must be adopted ; meanwhile, however, no interdisciplinary team set up for the purposes of such research will be able to do useful work before basing its analysis on a minimum theoretical foundation pointing to what needs to be known and why.

Ecology, dealing with the study of natural systems, can provide such a theoretical base. The concepts, whether in quantitative, theoretical or applied ecology, by now are on the way to being soundly established, but will of course have to be studied at greater depth. Use of these concepts for solving the development problems of human societies also calls for more systematic study.

We shall now attempt to explain and comment on these aspects.

A. Ecological Aspects of Development (18)

In natural ecosystems which are left to themselves one always finds a tendency towards development. This tendency is due to the continuous absorption of solar energy and transformation into potential energy in the ecosystem, which can only maintain its structure and increase its complexity as a result of these processes. The great difference between living systems and abiotic systems is that the former tend to develop and improve in structure, composition, diversity and richness, whereas the latter tend towards uniformity and to gravitate to a state of maximum entropy, i.e. of minimum potential energy.

This is also true of human ecosystems, but like natural ecosystems they can only develop as far as the limits set by the energy available to them at the start.

The energy P available to an ecosystem is absorbed from the sun through photosynthetic organisms, and that is primary productivity. It is used by the ecosystem to build up the biomass B and for consumption by the activities of the system, which ecologists refer to as its respiration R.

As the ecosystem evolves, its biomass grows overall and respiration of the components of the system, i.e. its consumption of energy, grows also. In the case of natural ecosystems it has been found that the ratio B/P increases up to a maximum value so that, with a given energy input P, a system can sustain a maximum biomass in the particular conditions in which it functions. Moreover, the ratio P/R tends towards unity and all the system's output is consumed by it in making it function and maintaining the biomass B.

In the case of human ecosystems the energy P is often the same as for natural ecosystems, but it can be increased by an amount P' representing the contribution of other types of energy, especially from fossil fuels, supplied either directly or in the form of industrial products, such as fertiliser, pesticides, clothing, etc. In the same way one may lump together with the biomass all those structures which store energy, such as dwellings, means of transport, roads, etc., and which need to consume constant amounts of energy to keep the biomass in working order.

Thus ecosystems go through necessary stages, in the first of which P/R is greater than unity and the ecosystem is in what is considered to be an immature state, i.e. the stage in which there is surplus productivity as required for the system to develop. Ultimately, however, these ecosystems reach the stage of maturity, called the climatic stage, when P/R is of the order of unity and they then maintain a maximum biomass (B/P is at its maximum) and maximum efficiency in using the energy available. The diversity H of these ecosystems, i.e. their complexity, will then be at its maximum also, since H is proportional to B/P.

These principles of ecology are important for an understanding of the evolution of human ecosystems and their development or underdevelopment. Thus it has been found in ecology that when ecosystems at an advanced stage of maturity come into contact with immature ecosystems, they appropriate the surplus output P/R which the latter produce, generally by predatory means. They then prevent the immature systems from developing by depriving them of the energy they require for doing so. Likewise highly developed human ecosystems which are in contact with less developed ecosystems (towns and countryside, or developed countries and the third world) deprive them of surplus output.

Furthermore, it is well known in ecology that developed ecosystems with a P/R ratio near to unity are very stable compared with those with a higher ratio because their great diversity corresponds to stages near the climax. In the case of traditional human ecosystems such stability has sometimes been the despair of economists, who have called such societies "closed" and have proposed an array of strategies for "opening" them. "Opening" has in fact first consisted in disrupting and simplifying these ecosystems, thereby making them more immature and hence "exploitable". This stability and stamina are one of the qualities of developed ecosystems, which one cannot destroy without the risk of causing underdevelopment.

In what then does development in a human ecosystem consist ? In increasing production, which is almost always stated as the ultimate goal in rich countries ? If our ecological analogy is valid and if mankind's aim is a society which is stable and amply diversified, development will consist mainly in increasing consumption R inside the system as a result of activities performed by different groups, of creating new socio-economic categories, and of adding to the system's diversity.

The economic history of the United States provides many examples in support of this argument. After the last World War the city of Los Angeles succeeded in weathering the slump caused by the stoppage of military orders, because it had the ability to change over immediately. The engineers and technicians dismissed from firms like Hughes and Rockwell began by setting up their own small businesses using their past experience to manufacture sliding doors, servomechanisms, etc. Diversity was created spontaneously and the city's development thus promoted.

In Detroit the industrialist, Henry Ford, started off by going bankrupt twice because he wanted to produce his motorcars entirely in his own factories, but later he farmed out his production and made it more diversified by assigning a part to a number of subcontractors, leaving his own factories to do only the final assembly work, and this improved the stability of his manufacturing system.

Thus it is undeniable that simplified systems are unstable and keep having to be corrected, because they are not self-regulating and could only be made so by consuming part of their production. A new disease, a crisis or a drought, and the system which seemed so attractive collapses, as is witnessed by the case of the Sahel already mentioned.

Must one then conclude that no outside intervention is possible ? By no means. Assuming that development is a succession of stages of increasing complexity, what is required to increase the complexity is to further diversify the system and let new elements take root inside it so as to give it a new maximum productivity. This means increasing diversity H, which will cause an increase in consumption R. When consumption is maximum the system can develop no further, but in some cases it cannot develop even now, since it is so heavily disturbed and subjected to such considerable constraints. It is then necessary to increase the energy input P by adding a quantity P' of external energy to overcome the bottlenecks. Great care must however be taken as these techniques are still far from easy to handle.

In the case of the underdeveloped countries, a policy of substitution has been adopted which replaces traditional farming by intensive farming. This usually calls for a very high energy input which has to be paid for, and the system will owe its survival to the additional inputs of energy (P') in the form of fertiliser, motor fuel, pesticides, intensive research, capital, etc. and will have to export to the systems which supply all these forms of energy. The output consumed in the system will drop to $R_1 - R'$ (R_1 can be greater than R, while R' corresponds to the output exported and so not consumed within the system). Thus the addition of P' will give a primary productivity of $P_1 = P' + Pm$, which will be more than P, otherwise the operation would not pay. This makes $P_1\ (R_1 - R')$ substantially greater than 1, which causes increased underdevelopment, even though accompanied by growth which does not all go to supply external markets.

An evolutionary policy can however meet the requirements of development which must then however reflect the wishes of the people concerned and the conclusions of their thinking. As the latter's starting point can only be the basic situation, development must start from the same point. Development cannot be undertaken on people's behalf - it is the people concerned who must decide on the increase in consumption R, with the aid of energy brought in from outside which must always be less than the energy required by a policy of substitution.

Apart from a few rare examples, the facts show that in underdeveloped countries any attempt to impose cultural change on a population has failed, either because the population has rejected it outright, which is usually the best course, or because the change has been adopted wholesale at the expense of all ethnic values and with no attempt to adjust to local conditions or to the native genius of the population's culture. The consequences, such as a population explosion or the introduction of diseases like bilharzia have usually been dramatic..

The fundamental tenet of ecological development concepts is that consumption is the basis. Consumption must of course allow for the amount of available energy (B/P must not exceed a certain maximum) and must be decided by individuals, while the means to achieve it will depend on their productivity. The present policy of accumulating wealth and profits leads only to the development of those individuals who succeed at the expense of those who do not succeed or who have not the means of doing so.

The principles on which ecosystems, including human ecosystems, function and all their social and political implications apply also to the rich, developed countries. But the reason why the latter seem so well protected from the difficulties is because they receive resources from all over the world and because their populations cannot obtain a thorough insight into the real implications of their system. Since we represent parasitical ecosystems in relation to the rest of the world, we naturally feel, as parasites do, that everything is for the best. Parasites may however end by dying, and our society as it now functions may hence well disappear, following the example sometimes found in predator-prey or host-parasite relationships, when the prey or host is destroyed or develops its own system of defence.

These are some of the principles of ecology as applied to the problems of development and we hope our explanation of them has been easy to grasp. The foregoing picture of development problems is clearly still incomplete since, while quantitative ecology is a most promising science, it is still in its infancy, and since it is always dangerous to try to take a still imperfect theory of natural systems and apply it badly to human systems. As a picture of the problems raised by the environmental crisis it may also be wrong, although we do not think so, since the universal laws of nature cannot be broken without disastrous results, and since whether we like it or not man is but a link in the chain of natural systems. However, we repeat that we do not intend to uphold any such new theory as an ecological ideology. We merely propose to study nature's economic laws and try to see whether they can be made to cover the working of human societies, as this method seems to us to be a fruitful approach to interdisciplinary environmental research.

B. Possible Lines of Environmental Research

We consider that in seeking a health development policy one must take account of economic and natural laws and that a grasp of the operation of ecosystems is therefore of prime importance. By an ecosystem we mean, as already stated, any more or less man-made complex system, a definition which implies a necessary combination of natural sciences with human sciences to an extent depending on how far the type of ecosystem under study has been influenced by man.

As the main environmental problem is to prevent the disastrous development process we are now witnessing, i.e. to prevent the degradation of ecosystems, it is especially important to study the laws regulating them and the dynamic principles on which their operation is based. They include more or less mature, and therefore more or less stable ecosystems, so that the subject to be studied is their reactivity and evolution under the influence of external or internal change. The ideal is to obtain dynamically stable ecosystems, a thorough investigation must be made of the conditions in which they change from the mature state to the immature or underdeveloped state, and conversely from the immature state to the mature or developed state.

Thus environmental research should follow two paths which will interact closely with each other, namely,

a) a thorough study of existing ecosystems providing a store of information on which to build up a general theory of the operation of ecosystems ;

b) the development of a general theory of ecosystems, whose concepts, as and when they take shape, will help in guiding.

These experimental and theoretical aspects of environmental research resemble the aspects already stressed by many writers in discussing the study of natural ecosystems. As early as 1964, for example, E.P. Odum (19) described them as a "systems ecology". He wrote : "... the new ecology is thus a systems ecology - or to put it in other words, the new ecology deals with the structure and functions of levels of organisation beyond that of the individual and species".

G.M. Van Dyne (20) discussed these aspects in 1966 and stressed the urgency of this type of research. He wrote : "The long-term impact on man of fundamental, total-ecosystem research should be recognized and the framework should be developed for extensive and intensive intercooperation of these three groups of ecologists. Analytical and experimental research on total-ecosystem complexes should be initiated as soon as possible, if man is to benefit tomorrow, because most problems of environmental magnitude require many years of study before conclusions may be reached."

This is as true of the study of ecosystems in the general sense as of the study of natural ecosystems which are only a part of the general systems.

C. Thorough Study of Existing Systems

There is a remarkable lack of information on existing ecosystems and on those which are dying out, so that there is a vital need to make case studies of them, and especially of the moribund systems whose disappearance would certainly deprive us of a most valuable basis of comparison for understanding the general laws governing the operation of ecosystems.

The fact must, however, be collected meaningfully, i.e. must relate to the assumptions to be verified in order to define a basis from which to start. Pending the formulation of certain general theoretical concepts, models can to some extent be used to point the way to the right parameters to measure, as models can be good testing-grounds for assumptions (21).

The investigation procedures depend on the types of ecosystem studied, which fall into two main groups :

Humanised ecosystems, i.e. mainly urban and agricultural ecosystems, and a knowledge of these traditional systems is essential as a starting point in studying a development policy, because by explaining the sociological, anthropological, biological and economic aspects of change it enables the problems raised by development to be better indentified.

For example recent studies, especially in anthropology, have shown with increasing clarity how rich a store of knowledge and ecological perception there is in many human systems. This knowledge and perception is indispensable to rural societies, for example, in carrying out their economic activities and has been developed by adaptive interaction between the natural and cultural environments.

Urban ecosystems are among the most difficult to study, because they are in course of rapid change and their social structure is continually being undermined. In this sense one cannot say that a town is usually a mature system and studies are now being made to try to determine the state of maturity of urban ecosystems, which are in fact economically very powerful, but prey like parasites on the rural ecosystems.

If our conception of development is as outlined above, we must consider human beings from the biological as well as the psychological and sociological standpoints, but in doing so we must take great care in choosing the parameters. For example, it has become very difficult to define "health". It is thus possible to organise the diet and way of life of a society so that the diseases of childhood malnutrition disappear, but at the cost of increasing a whole set of so-called degenerative ills such as cardio-vascular diseases, obesity, high blood pressure and dental decay in adults.

Accordingly, if it is desired to understand what occurs in development, a study must first be made of all the factors in a society or population which make for balance or imbalance.

Many such studies have already been made and many of them have led to the conclusion that so-called traditional societies living at a low technological level by our normal standards maintain a remarkably even balance with their environment. On the other hand, dramatic cases are known of upsetting the balance, such as, for example, what has been called the genocide of a lengthy series of American Indian populations, sometimes as a result of alleged "good intentions", including action by missionaries. By changing a society's values this action has caused some populations to commit a kind of moral suicide and allow themselves to die out. A well-known example is a community in tropical America whose biology has been widely studied and in which the introduction of values which we are accustomed to regard as universal moral values, such as the preservation of a child's life, has upset its population control, the likely outcome being that the infanticide which it used to practice on a very small scale will give way to general underfeeding of the children.

However, there are more insidious ways of upsetting the balance. They often consist in launching big projects for improving a population's output and therefore its resources. Thus large dams have been built in Africa which have very often led to outbreaks of such parasitic diseases as bilharzia due to the lack of any preliminary study of balances. The final outcome of such projects for the population, instead of an improved diet, as expected from the increase in crops which in fact occurred has seriously impaired health as a result of the parasitic diseases.

All these examples show that it is absolutely necessary to start with a thorough study of all the states and cultural aspects of a population whose technology it is intended to develop, and also to keep it under constant surveillance, and this is true of all the populations in the world since all are undergoing development and change.

Detailed programmes for carrying out this surveillance already exist, e.g. the World Health Organisation drew up a biometric measuring programme in 1968 for following the trend in a population's diet, but not for determining it, since a population's physical condition depends greatly on climate.

As we have already pointed out, a study showing the structure and operation of an entirely man-made ecosystem will have to be interdisciplinary, but so far it seems that interdisciplinary dialogues can only be held, and an overall study planned can only be made, on the strength of the basic principles of ecology. As, moreover, the activities of man-made ecosystems pursue economic aims, ecology and economics should be closely combined.

The knowledge thus obtained, however, cannot be a monopoly of the universities, nor a mass of data stored in museums or institutes, but must accumulate and grow inside the different communities so as to become the mainspring of their development.

Having noted the strategic need for a theoretical basis and also the need to decide who should ethically benefit from the knowledge obtained, one still cannot discuss this study project without referring to its difficulties, which range from delimiting the "area of study" to problems of historical analysis (required to understand the dynamic of the system) and of quantification. While the economic aspects (measuring the factors of production, production itself, trade exchanges, etc.) can be analysed quantitatively, there are important structural, functional and behavioural aspects which cannot be described quantitatively nor a fortiori introduced into a mathematical formula. Thus the quantitative analysis must be supplemented by a descriptive, qualitative analysis of all the non-quantifiable aspects of the system under study. That is the problem in the human sciences, since here the approaches are so scattered that the area is still largely unexplored. Thus the methods to use and the problems to attack in studying the reactions of individuals to different types of ecosystem yet remain to be defined.

Natural ecosystems. The study of the operation of natural ecosystems has already provided many ecological concepts and principles enabling the general laws governing the way ecosystems function to be better understood (22).

Little or no study is being made, however, of a number of ecosystems and in particular of the interfaces or boundaries between different ecosystems. Scarcely anything is known about the hydrosphere,the atmosphere, the layers which bound certain compartments, such as the soil, the penetrating properties of water and pollutants, the edges of forests, the shores of lakes, estuaries (the ecosystems in brackish water are among the most seriously threatened) and so on. These boundaries are well worth studying owing to their great diversity and the immigration and emigration across them.

Studies of natural ecosystems should of course serve to work out a general systems theory and should therefore be planned with that end in view. This means that in the first stage quantities of component factors and their distribution in space, materials cycles and energy flows will have to be better defined. These parameters must be quantified systematically, which will involve long-term studies requiring large technological resources, but they are absolutely necessary if the aim is to understand how living species organise themselves and develop.

Towards a general theory of the functioning of ecosystems. A basic factor in the operation of ecosystems is the relationship between their organisation in space, their structure and organisation in time, and their operation. Since Schrödinger's time it has been known that the structure of an ecosystem can only remain stable if there are exchanges between its components and between these and the outside world, so that it is very important to ascertain the fundamental aspects of such transfers of energy and matter and how living organisms transform energy into organisation, i.e. to find the physical basis for the tendency to an orderly local accumulation instead of a progression towards homogeneous chaos and macroscopic uniformity.

This aspect of the problem leads straight to the important question of the direction an ecosystem takes and then to many other questions. What are the conditions which bring about change ? Can one assume that any pattern is possible for the components of ecosystems, or is the number of possible patterns limited ? This is an important question in man-made ecosystems, since human societies seem to have an extremely limited choice of avenues of development for a given biotope.

Should the conclusion be that natural ecosystems naturally evolve towards a limited number of patterns, the conditions governing such development must then be defined. It is already known that an ecosystem cannot keep growing without the aid of accumulation and consumption processes and that for a relatively short time it cannot develop without immigration. Taking a longer time-scale, it can evolve through reproduction, but development will be slowed down unless immigration is possible. This is a most important point, since the natural reservoirs of invading forces in the world are drying up. All these reservoirs should be protected, whereas the variety of them available seems now to be decreasing.

We have mentioned only a few of the basic questions to be solved in a general theory of the operation of ecosystems and they will require long-term research based on interdisciplinary and mathematical methods which are still in their infancy, including simulation and modelling with digital or analogue computers, the study of energy exchanges, systems theory, and, no doubt, much else.

THE ORGANISATION OF RESEARCH

A. Two types of research

Environmental research must start with practical studies, but need not necessarily become engrossed in solving immediately the problems it encounters, the danger here being that environmental research workers will be changed into technocrats owing to the urgency of the specific problems to be solved.

Environmental research must include two kinds of study.

First, solutions must be studied and proposed for concrete cases. This is a short-term task to be undertaken by multidisciplinary teams chosen to suit the features of each problem and including specialists in the natural and human sciences in proportions commensurate with how far the system concerned is man-made. They should of course include the specialists or generalists now being trained in the various environmental study courses.

Secondly, longer-term general problems should be studied. Without neglecting the urgency of preparing new alternative development policies which it should be possible to derive from the general laws governing the operation of ecosystems, it must be remembered that it was the hasty solutions worked out with no overall perspective which led to the environmental disasters facing us today. Interdisciplinary teams should do this second type of work and should therefore concentrate on laying the foundation for a theory of ecosystem operation. It is not for research staff but for the communities themselves, as we have already said, to work out their development policies.

B. The role of the universities

The universities or other research centres have a large part to play in a field where the direct use of research findings by communities must be made possible. They can help in many respects by :

- making communities aware of environmental problems and of their possible solutions ; the various experiments with decision-makers (23) are valuable but inadequate in as much as knowledge of these problems is still confined to a small minority ;
- pointing out the possible dangers to the environment of some particular regional planning decision or growth policy ;
- helping to solve the problems raised by the environmental crisis by doing research and providing advisers in the form of research teams to communities requesting them ;
- helping to build up data banks on ecosystems. These are indispensable if research work dealing mainly with complex systems is to make the fastest possible progress ;
- building up records of practical case studies to which local authorities may have easy access ;
- elaborate on studies already under way dealing with existing ecosystems ;
- developing fundamental research into the reactivity of ecosystems and the conditions governing their operation.

This work calls for a wide interface between universities and communities, as research centres or teams can and must learn much from human societies. Conversely, as we have already said, the knowledge so obtained must be handed back to the community, which will be the ultimate decision-maker. While the environmental crisis is partly a result of over-fragmented approaches to its constituent problems, it is also a result of imposing unduly technocratic decisions on human societies.

C. Level of research

It is in the tradition to say that research must be done at a very high level, but while this may well be true of fundamental research into the operation of ecosystems, it can no longer be so when the research is applied to development problems, because societies that wish to develop must understand how it can be applied and accept or reject the results on rational grounds. The research worker in an ivory tower speaking an esoteric language understood by only a minority of specialists would seem to have had his day and environmental education, more than any other, calls for a close interlocking of teaching with research.

Thus an important question for discussion is the level of environmental research, since everyone must be able to understand the findings. Yet action to popularise them must not encourage the belief that they are easily obtained in a field which is so complicated and calls for research workers with a great capacity for synthesis.

For example, recuitment of students of the environment for research work should be done as soon as possible, which is what these students themselves want anyway. Moreover, until they have acquired enough knowledge to synthesise, which they can do only at the postgraduate stage when genuine research becomes possible, it would seem essential to prepare them as early as possible for their research work. In fact first-year students can and should be introduced to research work so as to familiarise them with simple problems by collecting data, undertaking field studies of practical cases and so on.

D. Structures

By definition, environmental research stems from an interdisciplinary approach and probably cannot be done, therefore, in traditional specialist research centres. Hence, laboratories or research centres for it must be set up in which researchers from different disciplines will be employed on practical problems. These establishments should of course be closely linked with the specialist research centres, for example, by means of interlocking boards, so as to facilitate the exchange of experience.

The principle should be firmly established that the teams, and even more so their members, must be mobile so as to prevent any dispersal of effort and ability, as well as ossification in a field of research which requires a great amount of drive.

E. Constraints due to history and the university system

Environmental research requires, in addition to material resources and ad hoc structures, qualified research staff. The latter, such as systems theory specialists, have however not yet been trained, so that at the outset specialists in the traditional disciplines will have to be engaged.

If, however, (as in France) research workers can only hope to make a career in their initial disciplines, and as the research services do not yet include a branch for the environment, it is to be feared that those who hope to see good quality research workers leave their present jobs to do environmental research will be disappointed.

It is also possible that the environment, being a new and largely open field of study, may attract mainly second-rate researchers who feel they have not yet been sufficiently rewarded by the disciplines they were brought up in. Thus the recruitment of good quality researchers presents a problem and is one of the reasons why environmental research has made so little progress to date.

F. Co-operation at home and abroad

Co-operation at home and abroad is necessary and must be established soon for several reasons :

- even short-term environmental problems often transcend the boundaries of an area or country, e.g. in Europe the pollution of the Rhine affects Switzerland, Germany, Belgium, France and the Netherlands ;
- all countries belong to one and the same large ecosystem, the ecosphere, and the sub-system which they form are inevitably interdependent. Every country must therefore try to devise a development policy which will not hurt the other countries, but this is far from what happens today ;
- environmental research workers are much too scarce for each country to be able to wait calmly, even if it wanted to, until new researchers are trained ; it must therefore take steps to remedy the shortage ;
- due to their initial training, environmental research workers are usually specialised in a very narrow field. When a country has a practical environmental problem for which it does not have the right specialist(s), there must be arrangements to enable it to call in someone from abroad who is familiar with the questions to be solved.

Consequently :

- specialisation by universities or research teams in particular areas should be accompanied by recruitment, for a fixed period, of specialised research workers from the different countries concerned having a detailed knowledge of the particular area of ecosystem ;
- staff shortages in particular sectors can be avoided by taking a national census in every country, and in the world as a whole, of all the available research workers ;
- in addition to helping with the study of problems in some given area, these research workers should be given courses, lasting one academic year or less, in research establishments abroad to widen their experience and give their foreign colleagues the benefit of their own experience.

REFERENCES

1. J. PLATT - Science, of 28th November 1969.

2. H. BROWN - "Human Materials Production as a Process in the Biosphere",Scientific American, 223, (3), 1970, pp. 194-208.

3. D.H. MEADOWS, D.L. MEADOWS, J. RANDERS, W.W. BEHRENS III - The Limits to Growth, Universe Books, New York, pp. 56-59.

4. A. SIMANTOV - OECD Observer, 68, Feb. 1974.

5. The Limits to Growth, op. cit. pp. 71-80.

6. P.F. CHAPMAN - Energy Production - A World Limit ? New Scientist, 47 (720), 1970, pp. 634-636.

7. S.M. GREENFIELD - Man's Impact on the Global Environment, M.I.T. Press, 1970.

8. C. FOURIER - Traité de l'Association Domestique Agricole, Bossange éd, Paris ,1822.

9. J. VIEIRA DA SILVA : "Table Ronde sur Ecologie et Développement du Tiers-Monde". Offprint, University of Paris VII, Laboratory of General and Applied Ecology, Paris, 1973.

10. A.W. EIPPER - "Pollution Problems, Resource Policy and the Scientist", Science, 169 (3940), 1970, pp. 10-17.

11. K.E. BOULDING - The Economics of the Coming Space Ship Earth H. Jarrel ed. 1966; The Everlasting Universe , L.J. Forstner and J.H. Fodd ed, 1971.

12. W. BECKERMAN - "Environmental Policy : The Contribution of Economics" OECD Observer, 60, 1972, pp. 34-36.

13. M. BATES - "Man's Place in Nature" in : The Everlasting Universe op. cit. pp. 46-56.

14. P. SHEPARD - "Ecology and Man : A Viewpoint" in : The Everlasting Universe, op. cit.

15. H. BROOKS - Science, Growth and Society - A New Perspective, OECD, Paris, 1971.

16. This section is based on the introduction by J. Vieira da Silva to the Round Table referred to under (9) above.

17. V. LABEYRIE -"A propos de Quelques Conséquences Ecologiques de l'Organisation des Transports", L'Espace Géographique, 1, 1973, pp. 5-20.

18. See "Table Ronde sur Ecologie et Développement du Tiers Monde", op. cit. The arguments in this paragraph are taken from discussions at this round table conference of ecologists, economists, sociologists and geographers.

19. E.P. ODUM - "The New Ecology", Bioscience, 14, 1964, pp. 14-16.

20. G.M. van DYNE - "Ecosystems, Systems Ecology, and Systems Ecologists", O.R.N.L. 3957, June 1966.

21. In this connection see, for example, I.W GOODALL : "Mathematical Models in Ecology", 12th Symposium of the British Ecological Society, J.N.R. Jeffers ed., 1971, pp. 173-194 ; N.E. KOWAL. "A Rationale for Modeling Dynamic Ecological Systems " in: B.C. Patten: Systems Analysis and Simulation in Ecology, 1971, pp. 123.191.

22. K.E.F. WATT's excellent work Principles of Environmental Science contains a list of what now seem to be well-established principles of ecosystem operation.

23. See Part Two ; Chapter 4, by V. GIACOMINI.

ANNEXES

Annex 1

LIST OF PARTICIPANTS AT THE RUNGSTED CONFERENCE

NATIONAL DELEGATES

BELGIUM

W.E. van den BRUEL
Professeur
Faculté des Sciences Agronomiques, 5800 - Gembloux

J. HUBLE
Professeur
Laboratoire d'Ecologie Animale et Conservation de la Nature
Université de Gand Ledeganckstraat, 35. B - 9000 Gand

P. LACONTE
Directeur
Université Catholique de Louvain, 14, rue de l'Espinette
B - 1348 Louvain-la-Neuve

CANADA

H.F. FLETCHER
Chef de la Division des Relations avec les Universités
Chef de la Direction des Ecosystèmes du Ministère de l'Environnement, Edifice Fontaine, Ottawa K1A OH3, Ontario.

I. GABBOUR
Directeur de l'Institut d'Urbanisme
Université de Montréal, C.P. 6128, Montréal 101, Québec

M. RICHER
Sous-Ministre de l'Education. Canada

DENMARK

A. BAK
Professor
Chairman of the College of University Headmasters,
University of Copenhagen, Frue Plads, 1168 Copenhagen K

M. BOLL
Professor
University of Odense, Niels Bohrs Allé, 5000 - Odense

T. FENCHEL
Professor
University of Århus, 8000 - Århus C

DENMARK
(cont'd)

J. HEDEGAARD *
Professor, Dr. ès Sciences, The Polytechnical University
(Chairman of the Steering Group for the Conference)
DI 2800 Lyngby, Copenhagen

A. MICHELSEN
Professor
Institute of Biology, University of Odense
Niels Bohrs Allé, 5000 - Odense

K.R. RASMUSSEN
Professor
President of the Environment Centre, Chemical Institute
Den Kgl. Veterinaer og Landbohøjskole
Thorvaldsensvej 40, DK 1871 - Copenhagen V

S. STRUWE
Lektor
University of Copenhagen, Institute for Sporeplanter
Ø Farimagsgade 2D, 1353 - Copenhagen K

S.E. JORGENSEN
Pharmacy University, Copenhagen

FINLAND

C. von BONSDORFF
Academy of Finland, Lauttasaarentie 1, 00200 Helsinki 20

M. LAHDEOJA
Ministry of Education, Rauhankatu 4, 00170 - Helsinki 17

H. TOIVENEN
Academy of Finland, Lauttasaarentie 1, 00200 - Helsinki 20

FRANCE

J.M. ABILLON*
Maître Assistant
Département de l'Environnement, Université de Paris VII
2, Place Jussieu, 75005 Paris

J.P. BECHAC
Professeur de Génie Sanitaire
Ecole Nationale de la Santé Publique
Avenue du Professeur Léon Bernard, 35, Rennes

V. LABEYRIE *
Professeur
Directeur du Centre d'Etudes Supérieures d'Aménagement
Université François Rabelais, Parc Grandmont, 3720 Tours

P. TREHEN
Maître Assistant
Institut du Comportement et de l'Environnement
Directeur de la Station Biologique de Paimpont
Université de Rennes, 35380 Plelan le Grand

---

* Those persons whose names are followed by an asterisk were members of the Steering Group for the preparation of the Conference.

GERMANY

P. SCHNEIDER
Professor
Geography University of Essen, D-43 Essen, Henri Dunant Str. 65

IRELAND

K.I. NOWLAN
Head of the Department of Town Planning
University College, Earlsfort Terrace, Dublin 2

ITALY

V. GIACOMINI*
Professeur
Directeur de l'Institut de Botanique, Citta Universitaria, Roma

JAPAN

E. TAKAKUMA
Dean
School of Medicine, University of Hokkaido - Hokkaido

T. TAKAMATSU
Professor
Department of Chemical Engineering, Kyoto University - Kyoto

NETHERLANDS

D.J. KUENEN
Professor of Environmental Biology, Wolfhezerweg 91 - Wolfheze

H. PETERS
Lecturer in Chemical Sanitary Engineering, Langenkampweg 105
Enschede.

A.W. SWETS
Inter-Faculty Working Group on Environmental Studies
Municipal University Amsterdam, c/° Plantage Muidergracht 14
Amsterdam.

A.M.M. VOSMAN
Inter-Faculty Working Group on Environmental Studies
Municipal University Amsterdam
c/° Plantage Muidergracht 14 - Amsterdam.

NORWAY

B. BJØRNDAL
Institute of Educational Research, University of Oslo - Oslo III

R.G.F. FORT
Ministry of Environment, Oslo 1, Oslo Dep

P. HOFSETH
Environment Programme Coordinator, University of Oslo
Blindern - Oslo 3

C. KROHN
Research Director
SINTEF, Norwegian Institute of Technologie
University of Trondheim, N-7034 Trondheim NTH

I. AULIN
Institutearchitect, Institute of Town and Regional Planning
University of Trondheim, N-7034 NTH

SWEDEN

L.E. DANFORS
Assistant Professor
Royal Institute of Technology. S10044 - Stockholm

H. STENRAM
Assistant Professor
Environment Studies Programme. Helgonavagen 5, S223 62 Lund

TURKEY

F. YAVUZ
Professor
Faculty of Political Science, University of Ankara - Ankara

UNITED STATES

W. BOGAN
Director
Division of Educational Technology and Environmental Education
Office of Education, Department of Health, Education and Welfare
Washington D.C. 20202

YUGOSLAVIA

K. TARMAN
Professeur
Faculté Biotechnique. Krekov trg 1, 61000 Ljubljana

O.A. WEBER
Professor
Chairman, Yugoslav National Committee for the Man and Biosphere
Programme. P.O.B. 291, YU-41001 Zagreb

EXPERTS

AUSTRALIA

A.A. BROWNLEA
Foundation Professor in Environmental Studies
Griffith University Nathan, Brisbane, Queensland, 4111

BELGIUM

J. BORMANS
Directeur du Département Technique
Fédération des Industries Chimiques de Belgique,
Square Marie-Louise, 1040 Bruxelles

CANADA

G. FRANCIS*
Professor and Chairman
Department of Man-Environment Studies, Faculty of Environmental
Studies, University of Waterloo - Waterloo, Ontario

P.H. JONES
Professor
Director of Institute of Environmental Sciences and Engineering
University of Toronto, Toronto 5, Ontario

DENMARK

E. JELSØE
Student
The Danish Student Organisation - Copenhagen

G. MEATHIESEN
Student
The Danish Student Organisation - Copenhagen

FRANCE

G. BOETSCH
Etudiant
Département de l'Environnement, Université de Paris VII
2, Place Jussieu - 75005 Paris.

G. CHARBONNIER
Producteur d'Emissions Scientifiques O.R.T.F.
51, avenue de la Porte de Villiers, 92300 Levallois

M PETETIN
Etudiant
Centre d'Etudes Supérieures d'Aménagement
Université de Tours - 37200 Tours

J. VIGNERON
Maître Assistant
Département de l'Environnement, Université de Paris VII
2, Place Jussieu - 75005 Paris

NETHERLANDS

J. van SPAANDONK
NRC Handelsblad, Westblaak 180 - Rotterdam 2

SWEDEN

L. EMMELIN
Environmental Studies Programme, Helgonavagen 5, S 223 62 Lund

L. GILDHOLM
Linköping University, S 581 83 Linköping

P. HALLBERG
Linköping University, S 581 83 Linköping

UNITED KINGDOM

J. BOSSANYI*
Senior Tutor in Biological Sciences, Department of Extra-Mural
Studies, The University of Southampton, Southampton SO9 5NH

A. CANE
Deputy Editor
Times Higher Educational Supplement, Printing House Square
London EC4P 4DE

R. CLARK
Education Centre, The New University of Ulster, Coleraine
Co. Londonderry, N. Ireland

T. DAVEY
University of Reading School of Education, London Road
Reading RG1 5 AQ

UNITED KINGDOM
(cont'd)

W.E. MARSDEN
Lecturer in Education, The School and Institute of Education
The University of Liverpool, 19-23 Abercromby Square
Liverpool L69 3BX

P.J. NEWBOULD
Professor
The New University of Ulster, Coleraine
Co. Londonderry, N. Ireland

M.F.W. WILLEY
Student
Department of Extra-Mural Studies, The University of Southampton
Southampton SO9 5NH

UNITED STATES

A. BINDER
Director and Professor
Program in Social Ecology, University of California, Irvine
Irvine, California 92664

E.A. FERNALD
Director and Professor
Florida Resources and Environmental Analysis Center,
The Florida State University, Tallahassee, Florida 32306

D. KRIEBEL
Student
The University of Wisconsin-Green Bay, Green Bay, Wisconsin 54302

C.E. NELSON
Director
Environmental Studies Program
Indiana University, Jordan Hall 018, Bloomington, Indiana 47401

A.L. PRATT *
Dean
School of Technical Careers, Southern Illinois University
at Carbondale. Illinois 62901

G.H. SEWELL
Head
Division of Environmental Health Sciences, School of Public Health,
Columbia University, New-York

E.W. WEIDNER
Chancellor
The University of Wisconsin-Green Bay, Green Bay
Wisconsin 54302

INTERNATIONAL ORGANISATIONS

World Environment and Resources Council (WERC)

A. CANINO
Secretary General
FAST-P. le R. Morandi, 2 - 20121 Milano, Italy

UNESCO

J. CELECIA
Programme Specialist, Division of Ecology
Place Fontenoy - Paris 7e

H.A. FOECKE
Director
Div. Of Pre-University, Science and Technology Education.
Paris 7e.

Centre For Education in International Management (CEI)

M. ROYSTON
Faculty Member
Environmental Manpower
4, chemin de Conches, 1211 Conches-Genève. Switzerland

W.H. MATTHEWS
Professor
Department of Civil Engineering, M.I.T.
4, chemin de Conches, 1211 Conches-Genève, Switzerland

United Nations Environment Programme (UNEP)

C. SURIYAKUMARAN
Director of Technical Assistance and Training
P.O. Box 30552, Nairobi - Kenya

Commission of European Communities (CCE)

M. TROUSSON, rue de la Loi 200, 1040 Bruxelles.

International Union for Conservation of Nature and Natural Resources (IUCN)

D.J. KUENEN
Professor of Environmental Biology
Wolfhezerweg 91 - Wolfheze, Netherlands

World Health Organisation (WHO)

J. KUMPF
Chief
Promotion of Environmental Health, WHO Regional Office for Europe
8, Scherfigsvej, DK - Copenhagen , Denmark

S.J. ARCEIVALA
Sanitary Engineer, Regional Office for Europe - Copenhagen

Food and Agriculture Organisation (FAO)

H.A. HILMI
Education Officer, Forest Resources Division, Rome, Italy.

Secrétariat Professionnel International de l'Enseignement (S.P.I.E.) TUAC

M.C. BERNARD
Avenue G. Bergmann 111 - 1050 Bruxelles, Belgium

Attending the Opening Plenary Session on Tuesday 4th June 1974 :

H.R.H. Prince HENRIK of Denmark

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